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"WHAT CAN SCIENCE OFFER THE OYSTER GROWER"

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INTRODUCTION

As we gather here today on the shores of historic Chesapeake Bay to discuss the problems of the great shellfish industry I am deeply conscious of the debt we owe to this area. It was here in Chesapeake Bay that the great biologist, the late Dr. William Keith Brooks of the Johns Hopkins University, undertook the first studies of the oyster in America. In 1878 he organized the Chesapeake Zoological Laboratory and during the following twenty-eight years during warm weather he was always at the seashore accompanied by a party of students. In keeping with the early traditions of the Johns Hopkins, the available money was mostly put into brains, not into buildings and boats. Starting with a vacant warehouse at Fort Wool* and three rowboats furnished by the Secretary of War, the group moved the next year into three barges of the Maryland Fish Commission at Crisfield, Maryland. In 1883 the laboratory was located in a building leased from the Normal School in Hampton, Virginia, but a few moments drive from where we are now gathered.

Thus we meet today in the very heart and home of oyster research in America. May we pause for a moment to pay tribute to this great scientist. As Chairman of the Maryland Oyster Commission Dr. Brooks submitted to the General Assembly of Maryland in 1884 a comprehensive report on "The Development and Protection of the Oyster in Maryland." If his recommendations had been followed there would be only one oyster problem for Chesapeake Bay today; where to find markets for the vast numbers of oysters produced on the prolific reefs of this area.

Of greater value to the country as a whole, however, has been the legacy Dr. Brooks left us in his students; Dr. James L. Kellogg long of Williams College Massachusetts whose work on molluscs has yet to be surpassed and whose student, David Belding, made such substantial contributions to the oyster, quahaug and scallop fisheries of Massachusetts. Dr. Caswell Grave for some years biologist of the Maryland Oyster Commission whose student, Dr. E. P. Churchill initiated the program of research on oyster larvae of the Fish and Wildlife Service. Lastly the even greater work and influence of my father, the late Dr. Julius Nelson at Rutgers, who lives on not only in your speaker but in William H. Dumont and in Jim Engle of the Fish and Wildlife Service, in Dr. C. A. Perry of the Maryland State Department of Health and Dr. C. Roy Elsey

of British Columbia, in Dr. L. A. Stauber, Dr. H. H. Haskin, and Dr. M. R. Carriker now at Rutgers, and Dr. A. F. Chestnut of the University of North Carolina's new Institute of Fisheries Research at Morehead City. Here also I must include my brother, Mr. J. Richards Nelson, who while still a student at Rutgers fell under the influence of the Brooks tradition and switched his loyalties from poultry husbandry to oyster farming. Through these men may this great scientific tradition carry on in ever widening circles.

The needs of the industry and the accomplishments of Science

The primary and basic needs of the oyster industry are:

1. A dependable supply of seed
2. Protection from enemies
3. Good growing and fattening grounds
4. Protection from industrial and domestic pollution.

What has science actually contributed thus far to the welfare of the industry and what prospects are there for the future?

1. Obtaining seed oysters

During the first decade of the present century Dr. Stafford in Canada and my father, the late Dr. Julius Nelson of Rutgers College in New Jersey, studied and described the free swimming stages of the oyster larvae and the conditions under which they are able to attach. The slide shows the first photograph ever taken of an oyster larva. It was made by my father in 1908 and published in his annual report in 1909. It represents a larva 9-10 days old. To these two scientists must be given credit for first demonstrating the importance of clean shells as cultch. They showed that spawning of the American oyster begins at a temperature close to 70 degrees Fahrenheit and that it is possible through microscopic ex amination of the water to determine the probable time and intensity of the expected oyster set.

Following the death of Dr. Julius Nelson in 1916 his work was expanded in that year at the New Jersey Station to include the world's first survey of an oyster bearing area to determine the abundance and age of oyster larvae at different points. This survey of Little Egg Harbor, published in 1917, demonstrated: first, that the oyster larvae work up-stream away from the sea, and second, that through determining the age of the larvae the time of expected set could be predicted ten days in advance.

The advent of the first World War interrupted all oyster research, but the decade beginning in 1920 saw greater progress in oyster research and wider application of its findings than in any comparable period in our history. Lack of time prevents me from more than mentioning some of the more important discoveries. Churchill and Gutsell of the U. S. Bureau of Fisheries, working in Great South Bay, Long Island, confirmed our findings in Little Egg Harbor and Barnegat Bay, paving the way for the outstanding work of Prytherch and Engle and their associates at Milford, Connecticut. Meanwhile Joe Glancy and Wm. Firth Wells working quietly for the New York Conservation Department were the first to raise oysters from the egg to setting size. Dr. Galtsoff, newly arrived in this country from the marine station at Sebastopol on the Black Sea, joined the Bureau of Fisheries and plunged into a study of the oceanography of Long Island Sound especially as related to the oyster industry.

The story is an exciting one, typical of what we like to think as being truly American. Great industrial expansion incident to the First World War let loose a flood of industrial wastes that threatened by 1924 to wipe out the great oyster setting grounds of Bridgeport and New Haven harbors.

The personnel and financial resources of the U. S. Bureau of Fisheries were thrown into the struggle, in which they were joined by two men of outstanding ability and vision. To them we scientists and oyster growers of America owe eternal gratitude. The vision and the industry of Mr. Howard Beach gave us the Oyster Institute. His confidence in Dr. Radcliffe as its Director has been abundantly justified in the years that have followed. The Institute, and the Milford Laboratory are monuments to these two men.

Supported by the valiant work of our late lamented Captain "Shang" Wheeler in Connecticut, and of Dr. Connelly in Rhode Island, pollution was greatly abated, inshore spawning areas were restored and the great Long Island oyster industry was saved. How typically American is this story, science and industry working together hand and hand to solve our common problems. The very valuable bulletins issued by Dr. Loosanoff at Milford are the latest evidence that through the aid of science oyster sets of abundance can be obtained in nature.

Of vital interest in the possible role of spawning sanctuaries in increasing seed production is the important question of how far may oyster larvae travel during their two weeks of free-swimming existence.

The only unquestioned proof of distance traveled by an oyster larva of which I know is that of Dr. Roy Elsey of British Columbia who found a spat of the Japanese oyster attached to a boulder estimated at approximately five tons and situated some five miles from a bed of Japanese oysters introduced the preceding summer. There were no other Japanese oysters in the area and that boulder

certainly wasn't dropped off an oyster boat!

In Delaware Bay we have indirect evidence that in some seasons vast numbers of oyster larvae may be carried upstream as much as fifteen miles from the planting grounds to set on the natural beds above.

Where spawning sanctuaries have been set up we have repeatedly found much heavier sets up and downstream from the parent oysters. This would seem to support Prytherch's findings at Milford that larvae remain close to their parents throughout the entire two weeks larval period. Another explanation, however, is possible. In 1921 I described and pictured 62 mature oyster larvae ready to set from the stomach of an adult oyster. Such larvae do not remain long in the digestive tract of the adult oyster, but are quickly carried out of the intestine. On emerging from their accidental prison they have frequently been seen to push out foot and velum and to swim away. Two years ago a group of large oysters were brought to Surf City, Barnegat Bay, from a distance of some eight miles. Less than two weeks later a heavy set approximately two weeks old was found on the oysters themselves and upon nearby gravel. There were no parent oysters in the area save a couple of bushels of small oysters in trays. The heavy set, confined to the shells of the large oysters and the gravel all within a few feet strongly suggests that there were larvae in the guts of the big oysters when brought here and that on planting, the large oysters liberated their load of captured young which promptly set in the immediate neighborhood. With hundreds of thousands of oysters each pumping twenty, thirty or more quarts of water an hour vast numbers of oyster larvae must be captured and subsequently liberated. Absence of such capture by the adults may well be an important factor in the failure of a depleted oyster bed to rehabilitate itself. It deserves much further study. Here is a field where radioactive tracer elements can be used to great advantage.

After twenty years experience on the Cape May shore of Delaware Bay we can give you the following as definite facts. During eighteen of these twenty years intensely heavy sets of oysters have occurred upon the flats within a few feet of our laboratory. Setting has taken place continuously night and day for from four to as much as ten weeks as determined from shells placed and removed each 24 hours. As high as 600 spat per concave surface of a quahaug shell have struck within a single 24-hour period, with over 100 per shell each 24 hour period for more than two weeks. Since the flats run bare each low tide to a distance of 2500 feet, the larvae must be carried at least that distance with each flood tide. The only oysters seaward from our laboratory are on a small depleted natural bed -- the Drum Beds in the public quahaug area. We are forced to conclude therefore, that the bulk of these larvae are produced on the

planted beds above us and are carried seaward during early development. By successively sinking on the ebb and rising on the flood they return to our New Jersey shore. Due to the effects of the rotation of the earth they are carried toward the Delaware shore during ebb tide while being borne toward the New Jersey side as the tide swings to the right with the flood.

Outside the bar, situated some 3000 feet from the high water mark, and in 14 to 20 feet of water are hundreds of acres of oyster bottom which have been heavily shelled year after year. In the main these shells have caught fewer spat in an entire summer than attach to similar shells in one tide close to the shore. It is evident therefore that with each flood tide these larvae by countless billions pass by these shells to attach to shells in shoal water on the flats. We have had excellent success moving such heavily set shells offshore into deeper water when the oldest are but 10 days of age.

It is my opinion that no more important problem faces the Chesapeake Bay area than to determine the role of parent oysters in capturing their young and finding out how far the larvae are carried. Here is a field in which radioactive tracer elements or even staining as used by Dr. Loosanoff could be employed to great advantage. It is understood that Dr. Chipman has recently completed the training required in handling radioactive elements. May I urgently recommend the tracing of oyster larvae for his early consideration.

2. <u>Oyster enemies</u>

Much has been learned about the enemies of the oyster but so far science has yet to give us methods for the control of oyster enemies comparable to those developed for the eradication of insect pests, for example. Since boring snails are also molluscs, breathing through gills, they are so close to the oyster that it is very doubtful if any method of poisoning them can be found which will not harm the oysters or render them unfit for human food. The plan to kill oyster drills through corrosive sublimate, or bichloride of mercury, as recently proposed appears highly dangerous through the habit of the oyster loading up with heavy metals such as zinc, bismuth, lead, mercury or copper whenever these occur in appreciable quantities in the surrounding waters.

The six year study of the oyster drill, Urosalpinx, carried on by Dr. L. A. Stauber at our laboratory with the aid of W. P. A. and P.W.A.

funds showed conclusively that three methods of control are effective and that their use will pay dividends. Where much new shell growth is present on the oysters the drill trap should be used. This is a chicken wire bag filled with oysters younger than those which it is desired to protect. Oysters growers have long known that drills will attack the youngest oysters available while, Dr. H. H. Haskin in our laboratory proved that drills can distinguish between the excurrent water coming from oysters of different year classes up to four years of age. Bags of young oysters strung on trot lines will confer much protection to oysters on the bed. If placed around a bed comparatively free from drills such bags if frequently shaken to remove the drills will largely prevent invasion from adjoining beds. For use in transplanting we strongly recommend either the deck screen or deck plate of steel with holes closely bored to let the drills through. For cleaning a ground before planting we recommend the drill dredge.

Starfish are destroyed by quick lime but this cannot yet be considered a substitute for mopping. Much of the difficulty comes from vast populations of starfish on barren bottoms from which the free swimming larvae may be carried long distances in a few days. Discovery of an economic use for starfish would stimulate a fishery for them thus keeping down their num bers on the barren bottoms. A few years ago I was greatly interested as well as amused to overhear a well known zoologist who spends his summer at the Woods Hole Laboratory on Buzzards Bay, Massachusetts, express the fear that inroads on the starfish of that area to supply biological laboratories would soon so reduce the number of these animals that it would be difficult to find enough for his own research work. You men from the Long Island Sound area will smile at this, but does it not hold a lesson for us; that steady pressure on any species over an extended period will reduce the population to small proportions?

Great hope for oyster pest control in the future lies in the work of Dr. Sewell H. Hopkins and of his numerous associates of the Texas A and M Research Foundation working in the Gulf. I look forward also with anticipation to what Dr. Prytherch will tell us shortly of his control of oyster enemies in North Carolina. Of this much we can be certain. When oysters are planted on new bottom relatively free from enemies the returns are often very large. With each succeeding year, however, the oysters' enemies increase and unless these are brought under control may ultimately put the oyster grower out of business. The boom years of 1920 to 1930 in Maurice River Cove are a good illustration. New bottoms were being taken up where oysters had not previously been planted and hence were comparatively free from drills. Aided by the wettest year in New Jersey's history more than five million dollars worth of oysters were shipped from the Cove in 1928, putting New Jersey in third

place among the states with a production of one seventh of the total oyster crop of the United States.

With the onset of the depression new grounds were not taken up, three of the driest years of record plus a hurricane took their heavy toll, with drills and the mud worm, Polydora, reducing the oyster crop by approximately one half. New Jersey slipped back into fifth place among the states. Return to our former position can only be accomplished through vigorous control of oyster pests; especially the drill.

3. Favorable growing and fattening grounds

Here science has been of little help; the oyster grower has had to depend almost wholly upon his own experience and that of others. We do not yet know why oysters grow well on some grounds, poorly on adjoining grounds. Even on the same ground, as every oyster grower well knows, growth and fattening may be good one year, poor the next. Much scientific work has been done in this field but as yet there is little that science can tell you of practical value. From our experience in New Jersey we know that when the diatom Skeletonema is abundant we have had fat oysters of excellent flavor. We have seen oysters increase in yield almost a pint per bushel in one week following a heavy invasion of this diatom. When associated with objectionable forms such as the "gremlin" Bicoeca in Great South Bay in 1943 oysters may remain thin and poor even in the presence of abundant Skeletonema.

Our experience in New Jersey does not support the conclusion of Dr. Loosanoff and his coworkers that oysters in nature will not feed in the presence of thick suspensions of food organisms. We have found oysters to feed actively throughout dense swarming of the dinoflagellate Amphidinium fusiforme, when the water had turned red and was a veritable soup of these algae and of their zobspores. Since Dr. Loosanoff's observations were made under laboratory conditions while ours were made in the open waters of Delaware Bay it is probable that poisonous substances produced by the algae at Milford were either not present in Delaware Bay or were quickly destroyed in our open waters. I have to be shown before I will believe that oysters will starve and die in nature in the midst of abundant food.

4. Protection from industrial and domestic pollution

Although in the past some oyster growers have looked upon bacteriologists as their worst enemies, we must all agree that in the main sanitary standards have aided and protected the industry. It is encouraging to find the United States Public Health Service now engaged in active research looking toward new techniques for identifying objectionable bacteria and to sounder more reliable methods of determing the sanitary quality of shellfish.

Federal and state attack on aquatic pollution is being actively pushed in many quarters, industry is cooperating as never before, ready to spend money liberally for research on waste disposal. Noteworthy is the two million dollar project of the U. S. Public Health Service which will be launched July 1st for the control of stream pollution.

Concrete evidence of improvement of the waters of New York Harbor is seen in a group of oysters on exhibit in this room. The late Captain Will Elsworth told me in 1923 that he had caught his last oysters in the lower Hudson River in 1917 close to the Statue of Liberty. Exhibited here today is a group of excellent oysters dredged last December on Robbin's Reef within the very shadow of the Statue of Liberty. One is tempted to become sentimental, and to suggest that even the lowly oyster is enjoying the protection of our Goddess of Liberty.

Finally we shall learn during this convention of the excellent progress made by Dr. Loosanoff and his associates in raising oyster and quahaug larvae to setting size at the Milford Laboratory. Armed with such technique there is every reason to hope that through selective breeding we can obtain oysters and quahaugs capable of attaining market size in half the time now required. From the growth studies of Martin and ourselves in New Jersey and of Dr. Loosanoff at Milford we know that certain oysters in any lot will outgrow others by as much as ten to one. In my own studies of water pumpage by oysters it has been found that two year old Cape May oysters selected through rigorous competition in the heavy sets of that area, can out-pump eight year old Barnegat Bay oysters, grown from non-selected seed, by at least two to one. Since the oyster must obtain the materials for growth and fattening from the water which it pumps, it follows that ability to pump water is probably the most important characteristic of a vigorous oyster. Unless the oyster is very different from most other animals such vigor is inherited in at least a portion of the offspring. Selection of the fastest growers in each succeeding generation should soon give us an oyster comparable to the large Pacific oyster imported from Japan which has in eighteen months reached a size where eight of them will make a pint. This may sound fantastic but science has produced equally miraculous results with other domestic and game animals such as trout; why not with oysters? To accomplish our goal research positions in the shellfisheries field must be made sufficiently attractive in salary and in tenure to interest young men of ability and with adequate training. Above all they must have complete independence of, and protection from, political interference. Looking back over half a century it is clearly evident that bad politics has been a

far worse enemy of the oyster than pollution, star-fish, drills and all other natural enemies combined. You in this industry have the political power to protect the scientists who are ready and eager to serve you; their fate is largely in your hands in a future that is bright with promise.

Varying Characteristics of Oyster Bottom
-by-
Allan A. Sollers, Commissioner
Maryland Department of Tidewater Fisheries
Annapolis, Md.

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An oyster, Mr. Chairman and friends, is the one thing in the world that I envy. The lazy rascal spends just about his entire life lying in bed. To complicate the matter further, this fastidious gentleman is a bit particular about the kind of bed he lies in. If it is too soft he settles in and dies. If the bed is too hard and shifting he likewise is covered up and departs for the oyster spirit world. Hence we are compelled to take due notice of these eccentricities of our exacting bivalved associate; our personal economic welfare is dependent on it.

The uniniated, though otherwise well informed, might quickly ask, "Why haven't physical and chemical analyses been made of the submerged lands, the several classes established, and these classes correlated with their capacity to grow oysters?" He would doubtless substantiate his question by pointing out the work done by the agricultural experiment stations ashore and refer to the glib way that farmers speak of loams, clays and sandy soils, marls and the host of other classifications in that book.

Such a classification might be useful; I have discussed the question with those qualified and have never discouraged such an attempt. I have by the same reasoning never strongly advocated such an effort for fear of oversimplification. There is more to the problem than would show in a simple physical analysis of the ground in question. I will discuss variations, complications and exceptions later.

If an attempt were made to classify the submerged lands, the Chesapeake Bay would be a good place to make it; surely we have every combination in the world there, and maybe one over for good measure.

Three general classifications would be immediately apparent.

The first to attract attention would be the sands along the shore lines. They feel relatively hard and firm to the bare feet of bathers but they lack any adhesive or cohesive qualities and shift about with the pounding of the surf. Their extent off shore is dependent on the degree to which the area in question is exposed to heavy seas.

Second, just beyond the shifting sands, we again find sand, but something has been added. Mixed with the coarse grains of sand, are smaller particles that possess definite adhesive qualities. I am not sure

what these smaller particles are, probably some type of clay. In any event they hold the grains of sand in a fixed position in much the same manner that the crystals in babbit bearings are held by the soft mental around them. The relative amounts of the component materials vary widely, but as long as both are present we have a firm, stable ground that remains amazingly constant. This is the combination of constituents of the natural oyster rocks of Maryland. Here we find the seventh heaven or the happy home of the oyster in our State.

Third, beyond these reefs or bars the percentage of sand sharply diminishes and we are on the mud. Generally the mud bottoms are definitely not the best places to grow oysters. I hasten to concede that there are great differences in the quality of mud bottoms, but do not feet that I should take the time at this point to discuss even the little that I know about these variations. I leave the point with the admonition that mud bottoms are bad places for uninitiated oyster planters who are long on ambition and capital and short on experience.

If the three classifications set forth above make the problem seem easy and simple, I hasten to dispel that illusion. For instance, there is another class. I set it forth as an exception because it appears pretty much without rhyme or reason in relation to the pattern set out above. The geologists call it Plum Point Marl. There are more local names for it in Maryland than there are sinners in Hades. Some of the local names are Fullers Earth, Blue Clay, Foolish Earth, etc.; you may take your choice. Generally it is excellent oyster ground. It will not shift under the most severe pounding of the seas. Again, generally, it appears in pure form; that is, not mixed with sand or mud. I know of a couple of exceptions. In Poplar Island Narrows in Maryland and off Port Mahan in the Delaware Bay is to be found an admixture of this blue clay and mud. The combination is somewhat softer than the pure clay and the blue color is lost. The mixture is black or nearly so and is called mud, locally. The combination makes an excellent oyster bottom in spite of the fact that those immediately concerned appear to be at a loss to explain why.

I said a moment ago a simple classification as indicated might be deceptive. Mr. Engle of the Fish and Wildlife Service has prepared a paper describing a splendid piece of research work he has done in Eastern Bay, a tributary of the Chesapeake. The paper will be worth your attention. A brief discussion of the kind of oyster ground found there might be worthwhile for it shows the influence of another environmental factor and definitely does not fit the pattern set forth. Eastern Bay is simply an oversized sand pit filled with water. In the state servic e I have had to deal with it, and I frankly say that the place kept me talking to myself

until I finally figured it out.

Here I found oysters growing on loose sand, the type of sand that sensible oysters would not be caught monkeying with. Contradictory or not, they do grow there. Here are the observations and the conclusions. Eastern Bay has a very irregular shore line and is dotted with several small islands. Long narrow peninsulas nearby bisect it. There are many oyster bars. It was noted that the bars began at varying distances from shore. In some instances the bars began in two or three feet of water, in others it was necessary to go off shore until a depth of fifteen or sixteen feet was reached before oysters and the inner edge of the bars were found. When this depth factor was correlated with the depth and extent of the open water to windward, the answer was apparent. The oysters grew on the loose sand as soon as the depth of the water became sufficient so that the impact of the seas would not shift the sand about.

This paper would be incomplete without some mention of the loess of the sea. In some arid regions of the earth, interior China for instance, this material drifts about the winds. In our element, the water, we call it quicksand. It is death to oysters and forms the building material for the siliceous tube worms, sand coral or coral sand according to where you live.

It would be fine if one could pick up a sample of some oyster bed, run to a laboratory and receive definite and final assurance on the survival of oysters on it. Your speaker, in the absence of more precise methods, has learned to determine the quality of oyster ground with the simple devices generally at hand. These include sounding poles, orange peel bottom samplers and tongs. He would be glad of a more precise system of determination, but is wondering how long it would take him to get use to the new method.

The situation reminds me of a story told years ago, in steamboat days, about a waterman in my section who had spent most of his time on old schooners and work boats. He married and decided to go to Baltimore by steamboat for a honeymoon trip. The transition from simple sail to the luxury of steam presented problems. The first to bedevil him was the purser. Recognizing him as the bridegroom, the purser asked, "Do you want the bridal suite?" Appreciating the fact that this trick would cost him money, our friend asked, "What is the difference between that and the others?" "Oh, the bridal suite has a private bath," was the pursers answer. After a monent's hesitation the waterman replied, "Just a minute, Mister, I'll go ask my wife, for my part if I get seasick or something I'll run to the rail like I been doing."

I have never insisted on the study indicated in this paper, for I might be too much like the waterman just referred to. Confronted with the problem of determining the quality of a piece of oyster ground, I am afraid I would grab a sounding pole, go over the area in question and make a final decision without further ado.

The absence of the information and the classifications indicated in this paper are no fault of the scientific organizations. They are biologists and chemists not mind readers. It is up to the industry to make its wants known. If you fellows think that such a study would be useful, let's ask that it be made. It might prove useful beyond our wildest expectations.

VARIATIONS IN INTENSITY OF SETTING OF OYSTERS IN LONG ISLAND SOUND

-by-

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U. S. Fish and Wildlife Service,
Milford, Connecticut

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A good set of oysters in northern waters, including those of Connecticut, is not a rule but an exception. For example, of the past twelve seasons only four gave commercially important sets. Lightness and irregularity of setting are the chief handicaps of the oyster cultivators of Long Island Sound because the latter can never be assured that a new generation of oysters will be available to repopulate the beds.

At present the causes responsible for variations in the intensity of oyster setting in Long Island Sound are not fully determined and understood. Nevertheless, during the last twelve years, 1937-1948, enough new data have been collected which may help clarify some aspects of this important and interesting question. It is the purpose of this article to discuss some of the causes that may influence the intensity of setting.

We know that any species, in order to reproduce, should have a sufficient number of individuals to act as parents. Were our oyster beds depleted to such an extent that not enough spawners were present, lack of set could be ascribed to that cause. However, this probably has never occurred in our waters because there are always several million bushels of adult oysters in and near the area of the setting beds guaranteeing enough spawners. We cannot, therefore, consider the lack of spawners a cause responsible for the lack of set.

In some areas the failure of oysters to spawn could be advanced as a reason for the failure of setting. As a matter of fact, in some earlier articles discussing spawning of oysters opinions were expressed that in the deeper water of Long Island Sound oysters spawned only once in ten years (Nelson, 1928). Our observations showed, however, that this is not so. We found that oysters develop gonads and spawn every year. While the thickness of the gonads may vary from year to year, nevertheless, each year enough spawn is accumulated at the beginning of the spawning season.

There is no reason why the oysters in Long Island Sound should not spawn annually. Our records show that the summer temperature of the Sound is always high enough for the development of gonads and for inducing spawning. In depths up to about 40 feet a temperature of 20.0°C. or higher is maintained from about July 20 to September 15 or 20, i.e., approximately 55-60 days, a period long enough to permit the oysters to discharge their gonads completely. Even at the depth of 100 feet the temperature reaches 20.1 or 22.0°C. The majority of the oysters complete their spawning by about the first of September, approximately 15 or 20 days before the temperature begins to decrease below 20.0°C. (Loosanoff and Engle, 1942). Thus, failure of setting in our waters cannot be attributed to the failure of oysters to develop gonads and to spawn.

The failure of some aquatic species to propogate has been explained by the reason that a large number of the eggs discharged remained unfertilized and later perished (Thorson, 1946). This explanation cannot be applied to our oysters because, in their case, usually a large number of individuals spawn simultaneously, and this mass spawning insures fertilization of the majority of the eggs. On several occasions we observed spawning of oysters on the shallow bed of Milford Harbor. During the spawning the water over the bed was rendered milky with the discharged eggs and spermatozoa. Examination of the eggs showed that all were fertilized, thus indicating that there was no appreciable waste of eggs. A similar situation probably exists in the deep water beds. It is doubtful, therefore, that failure of fertilization is a cause responsible for the production of the small number of larvae.

On the basis of the presented considerations we may conclude that in Long Island Sound a sufficient number of oyster larvae is produced each year. These larvae are planktotrophic with a long free-swimming or pelagic life which, in our waters, is about 18 days. Larvae of this type, as Thorson (1946) points out, are "Cheap" because the eggs from which they develop are small, containing little yolk and, therefore, they can be produced in extremely large numbers. However, the initial advantage possessed by the oysters in producing a large number of eggs and larvae is counterbalanced by several disadvantages the first of which is, perhaps, the long larval period. During this period the larvae are exposed to the attacks of their enemies and are entirely dependent in their development upon the presence in the water of certain plankton forms which serve them as food. Furthermore, during this period the larvae are also exposed to continuous changes in their environment some of which may cause heavy mortality or the complete disappearance of broods of larvae.

Before proceeding to discuss the conditions that may, or may not, be responsible for the mass disappearance of larvae we should, perhaps, become familiar with the major events of the propagation of oysters in Long Island Sound. In the past a rather complex formula was offered for prediction of the time of the beginning of spawning and setting (Prytherch,1929). We find, however, that the situation is less complex than it appeared to earlier investigators. Our observations showed that spawning in Long Island Sound always begins either during the last few days of June or during the first days of July. The earliest date of spawning recorded was in 1945, or June 26, and the latest, in 1937, on July 3. Thus, in twelve years the beginning of spawning was confined to a calendar period of only eight days. We may be justified, therefore, to conclude that in Long Island Sound the beginning of the oyster spawning season should be expected on June 30 ± 4 days.

The beginning of spawning occurred at every lunar phase ranging from new moon to the last quarter. It was not related to definite tidal changes and, therefore, to the changes in hydrostatic pressure.

The earliest beginning of setting was recorded in 1941, on July 15, and the latest, in 1943, on July 23. Thus, in twelve summers the beginning of setting was confined to only about nine calendar days. Although it most often took place on July 17 we may, nevertheless, suggest that, for all practical purposes, in Long Island Sound the beginning of oyster setting should be expected on July 19 plus 4 days. The beginning of setting also happened at every moon phase and was not confined or even closely related to a definite tidal condition.

The formulae offered are based upon our observations which, I believe, are extensive enough to justify suggesting them. They should be found correct in the majority of instances but, nevertheless, we do not maintain that they should remain forever infallible. Some extremely abnormal conditions, not encountered thus far in our experience, may either hasten or retard spawning, or shorten or prolong the larval period to such an extent that the beginning of spawning or beginning of setting would take place outside the limits given in our formulae.

The setting season in Long Island Sound is of comparatively long duration. It usually extends from the third week of July to the end of September, and sometimes even to the first days of October. However, the intensity of setting

in time does not follow a rigid pattern from year to year but shows several variations. For example, in 1940 the first wave of setting was extremely heavy while the second wave was relatively light. In 1942, however, heavy setting came late in the season as part of the second wave. In 1944 setting continued almost uninterrupted during the summer but again the first wave was much heavier than the second. Finally, as in 1948, there may be two waves of setting of almost equal importance. In the latter case two distinct waves with pronounced peaks or maxima were especially well demonstrated.

The date of the peaks of setting showed no relation to the date of the beginning of spawning. In twelve years of observations the periods elapsing between the beginning of spawning and the day of maximum setting of the first wave varied from 16 to 40 days and averaged 30 days, and the beginning of the second wave varied from 47 to 66 days and averaged 56 days after the beginning of spawning. In time the date of maximum setting of the first wave varied from July 19 to August 10 and the second wave, from August 25 to September 12. These variations show that it is difficult to predict with any degree of accuracy the dates of maximum sets.

In search of signs of periodicity in the occurrence of the peaks of setting the number of days elapsing between the dates of maximum settings of the two waves of each year were determined (Table 1). The number of days for the year of 1938 is not shown in the table because the late setting in that year was a complete failure. The longest period between the two peaks was recorded in 1937, when 53 days elapsed between these two events. The shortest period of 23 days was noted in 1944. In the remaining years the period between the two peaks ranged between 28 and 38 days. Thus, as can be seen, setting of oysters not only varies in intensity from year to year but the peaks of the setting also do not show a definite time pattern.

What are the conditions responsible for the survival of larvae and, therefore, for variations in intensity and in the time of setting? Because our voluminous data are still not completely analyzed we can offer at this time only a general discussion of some factors without a complete evaluation of their importance. We hope, nevertheless, that later on, upon completion of a thorough statistical analysis of the material already available, we shall definitely establish the presence or absence of correlations between some of the ecological factors and intensity of setting.

Temperature is the first factor that always comes to mind when considering oyster propagation.

T A B L E - 1

Number of days elapsing between the dates of maximum setting of first and second waves, Long Island Sound, 1937-1948

YEAR	DAYS	YEAR	DAYS
1937	53	1943	---
1938	30	1944	23
1939	36	1945	28
1940	31	1946	34
1941	38	1947	35
1942	38	1948	37

It cannot be denied that low temperature prolongs the larval period, thus exposing the larvae for several more days to their enemies and other unfavorable conditions. However, we do not think that fluctuations in temperature in Long Island Sound during any particular summer or, as recorded during different summers, may kill the larvae. The old conception that a sudden decrease in temperature of 2 or 3° would kill the larvae has been disproven by our field observations (Loosanoff and Engle, 1940). Recent observations at Milford Laboratory by my colleague, Harry C. Davis, showed that if larvae kept at a steady temperature of about 22.0°C. were placed directly in cold water of about 8.0°C., and after being kept there for 30 minutes were again transferred back to 22.0°C., they would survive this treatment, even if it was repeated several times at two-day intervals. The work of Sparck (1927) also showed that the larvae of O. edulis withstood quick cooling from approximately 20.0 to 0.0°C., and were even able to survive at the latter temperature for at least 24 hours. Obviously, small fluctuations in temperature, as observed in the summer time in Long Island Sound, should not result in mass mortality of larvae.

Although temperature may affect the larvae by prolonging their swimming period or by affecting the quantity or quality of their food supply, no clear-cut relation was found between the departure of temperature from the mean during the periods between July 1 and September 30 and intensity of setting. It is interesting that the heaviest set of twelve years, which occurred in 1940, was during the year when the temperature departure was considerably below average. It is emphasized, however, that a further and more detailed analysis of our data may indicate that although no correlation between temperature and setting was noticed when long periods were considered, certain correlations may be found when the data are examined on a monthly, semi-monthly or weekly basis.

The changes in salinity in Lons Island Sound are so small that they certainly cannot be regarded as responsible for the mortality of the oysters. Roughly, our salinity range is between 25.0 and 28.0 parts per thousand. Usually the changes in salinity of the water for the

same period of the year seldom exceed 2.0 parts per thousand, and not in a single case did we find that the salinity for the corresponding week in twelve years exceeded 3.0 p.p.t. However, although these changes are not great enough to cause mass mortality of larvae they may, nevertheless, reflect on the production of the food on which larvae exist. This phase has not been thoroughly investigated as yet.

The percent of sunshine during the breeding period of oysters should also be considered as one of the factors which may have an important influence on the survival of larvae. This, of course, does not mean that intensity of light itself may kill or stimulate the growth of larvae. Its effect is largely confined to the growth of plankton forms which may serve as food for oyster larvae. Again, preliminary analysis of the data showed that in Long Island Sound the intensity of setting for the entire season was not correlated with the percent of sunshine during the period from July 1 to September 30. Nevertheless, it is possible that later on, upon a more detailed analysis, some correlation may become apparent.

Since, at present, none of the above discussed causes appears to be dominant in causing mass mortality of larvae, one, naturally, turns to look in another direction for an explanation why larvae disappear in our waters. We shall discuss two of the possible reasons, the first being extermination of larvae by their enemies and the second, death of larvae because of lack of food.

There is no doubt that a high percentage of larvae is eaten by their enemies, and that, in some cases, the presence of a large number of enemies may be the primary cause of failure of oysters to set. It is doubtful, however, that the failure of set in Long Island Sound is primarily due to that cause. Were we to assume that oyster larvae disappear because they are eaten, we would naturally expect to notice a similar disappearance of the larvae of closely related species of mollusks, such as clams, mussels, teredos, etc., which live in the same environment with oysters and have the same enemies. Our observations show that this is not the case. During several summers, including that of 1948, while oyster larvae were relatively few in number, the larvae of all ages of the clam, *Mya arenaria*, and of some other lamellibranchs were numerous. Furthermore, while the oysters failed to set in extremely small numbers, heavy setting of Mya and mussels continued throughout the summer. Thus, since, regardless of the presence of common enemies, the larvae of many lamellibranchs survive in large numbers to the setting stage, we should expect a similar rate of survival among oyster larvae. This, however, was not borne out by our observations.

We all know that in the southern states the fouling of shells with various organisms presents a definite problem because these organisms deprive the larvae of setting space. Most of these organisms are also larvae eaters. Furthermore, in addition to the bottom forms there are large numbers of jellyfish and other pelagic larvae-eating organisms. Yet, regardless of such a large variety and the large number of larval enemies heavy oyster sets occur rather regularly.

In Long Island Sound, on the other hand, the bottom fouling forms are fewer in species and numbers than, for example, in Chesapeake Bay or in the Carolinas. Although a few of our shells, planted in early July, may be found silted by the end of the season, very few of them would be encrusted with barnacles, ascidians, etc., as is almost always the case in southern waters. Obviously, the larvae enemies in our waters are not as numerous as in some other areas where good sets are, nevertheless, produced regularly. Thus, even if the larval period in our waters is longer than in the South, it still is improbable that the failure of our sets would be due almost exclusively to the activities of the larval enemies.

I can cite another example of the same type. In Connecticut waters the best and most consistant sets occur in the small, rather well-protected area of the Thimble Islands. The slopes of the shore of these islands are extremely heavily populated with different organisms which are plankton feeders. Large sections of the bottom are also heavily populated with larvae-eating invertebrates. Yet, regardless of such a predominance of enemies the oyster larvae there survive and set in large numbers, while the Sound proper experiences one failure after another. Obviously, if larvae enemies were the chief causes of failure of setting, the Thimble Islands area should not be a good place for the propagation of oysters.

We may conclude after the above discussion that while the importance of larval enemies is understood, and while it is recognized that the damage they do to the population of oyster larvae is rather extensive, it still seems improbable that in our waters, where the larval enemies are not as numerous as in other oyster-producing areas, failure of sets should be ascribed mainly to the activities of these enemies.

The final cause which we wish to consider in this article is that of lack of proper food for the oyster larvae. At first the suggestion that under natural conditions oyster larvae may perish from starvation in large numbers sounds highly improbable. Several years ago I would not even have considered such a suggestion because I know that, as a rule, the waters of Long Island Sound are comparatively rich in plankton. Yet, during the last few years, especially since the work on cultivation and physiology of oyster larvae was begun at our laboratory, more and more evidence is accumulating that oyster

larvae cannot utilize most of the forms of ultraplankton regardless of their small size. A more detailed discussion of this subject will be given to you by my colleague, Harry C. Davis, who did work on oyster larvae, while I shall limit myself to only a few remarks.

It has been found that the addition of mixture of laboratory cultures of ultraplankton forms measuring from 2 to 5 microns in size, thus small enough to be swallowed by the larvae, will not make oyster larvae grow. Apparently the mixture of plankton given to the larvae did not contain forms which could be assimilated by them. Yet, the same food given at the same time to cultures of larvae of other lamellibranchs was readily utilized by them. Thus, while, regardless of the presence of numerous ultraplankton organisms, oyster larvae refused to grow, the larvae of other species of lamellibranchs thrived on the same forms. This, of course, indicated the inability of oyster larvae to assimilate the ultra plankton forms which were present in the food cultures.

I think this phenomenon is extremely well illustrated by the experiment which I devised and which I asked my colleague, Mr. Davis, to perform for me. Last winter oysters and clams, <u>Venus mercenaria</u>, were made to spawn on the same day but in separate containers. A day or so later, after the larvae of both species had reached the straight hinge stage, we placed the larvae of the clams and oysters in the same container and began to feed them with a mixed culture of laboratory-grown food culture containing a large number of ultraplankton. Three days later the clam larvae had grown in size to 105μ while the oyster larvae were still 75μ. Five days after fertilization some of the clam larvae were already measuring 125μ, while the majority of the oyster larvae were practically at the same stage as at the beginning of the experiment. After eight days the clam larvae were over 140 while the oyster larvae were still between 75 and 80μ the majority showing no growth whatsoever. At the end of the ninth day the clams were growing very vigorously showing almost no mortality and measuring about 160μ while the oysters were dying in large numbers and those living were still measuring only between 75 and 80μ. After 12 days the clam larvae were finishing their free-swimming period and were setting in large numbers while all the oyster larvae were dead or dying. None of the oyster larvae were longer than 80μ.

Several variations of this experiment were run to be sure that the oyster larvae were not deprived of their food by the larger and more vigorous clam larvae. To achieve this some cultures were composed of a large number of oyster larvae and relatively few clam larvae. Regardless of the

ratios between the clam and oyster larvae and the ratios in number of larvae per given volume of water the results were always the same, namely, that the clam larvae grew very rapidly on the food they were given while the oyster larvae showed no growth.

Similar experiments were repeated by Mr. William Miller and me but instead of using hard shell clam larvae, the larvae of the surf clam, *Mactra solidissima*, were used. The results were the same - while the clam larvae grew, the oyster larvae remained approximately the same size they had reached upon entering the straight hinge stage. These experiments clearly demonstrated that oyster larvae cannot grow and survive on forms of ultraplankton which can be utilized by the larvae of other related species.

It is interesting that our observations on the food of oyster larvae are indirectly supported by a pioneer in larval culture, W. F. Wells. Wells established a hatchery at Cold Spring Harbor for the cultivation of oyster larvae but was unable to obtain any sets until the hatchery was moved to another location where the character of the water was different. Although at that time Wells did not realize the reason for his initial failure it is probable that the water of Cold Spring Harbor contained no micro-organisms which could be utilized by the oyster larvae. The new location, however, was probably rich in such forms.

Our field observations support our contention that there may be a difference in the ability of various mollusk larvae to utilize the food found in the water. For example, to any investigator familiar with the conditions in Long Island Sound it always appears peculiar that while clam larvae of all stages are almost found during the summer, oyster larvae seem to disappear within a few days after they hatch from the eggs. Is it not possible that this disappearance is due to the fact that during those periods our waters lack the food which can be assimilated by oyster larvae? Since it has been clearly demonstrated by our laboratory experiments that oyster larvae are unable to utilize many forms of ultraplankton, we are led to believe that the absence of proper food may be the cause of the failure of oyster larvae of Long Island Sound to live to the setting stage. This conclusion coincides with the opinion of Thorson (1946) who also thinks that lack of food is probably the chief reason responsible for the fluctuations of the larvae population in the sea.

Of course we still are very far from offering the final answer to this interesting and important problem. We know that in the first place it still is undetermined what forms in the plankton of Long Island Sound are utilized by oyster larvae. Secondly, the appearance or disappearance of such food forms would be very closely related to the environmental factors, such as probably

temperature, solar radiation, presence of certain nutritive substances, such as phosphates, nitrates, etc. These relations remain to be determined, and all the data should be more fully analyzed and studied. Nevertheless, I think we are now approaching the solution of the problem why the intensity of oyster sets in northern waters varies so greatly from year to year.

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PLANS AND PROGRESS OF OYSTER INVESTIGATIONS IN FLORIDA

-by-
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The great decline in oyster production of the State in latter years prompted the 1947 legislature to appropriate $100,000.00 to begin the rehabilitation of the oyster bottoms of the State and to encourage greater harvests.

Dr. F. G. Walton Smith, Director of the Marine Laboratory of the University of Miami was made director of the newly created Division of Oyster Culture to serve without pay. Mr. Robert Ingle, shellfish researcher of the Marine Laboratory, was appointed as Assistant-Director on a full time basis. Both men were given broad powers to make rules, regulate closed seasons.

Although the money was appropriated in 1947, actual setting up of the new activity did not begin until February of this year (1949) when the above appointments were made by the newly nominated Superintendent of the State Board of Conservation, Mr. George Vathis.

Progress thus far has been mostly in setting up a research program designed to establish some of the basic facts concerning the Florida Oyster. This survey will try to throw light on such subjects as these:

(1) How long do oysters spawn within Florida waters? When do they start, quit?

(2) If there are peaks in the spawning, can they be predicted, or do they follow any regularity?

(3) What is the growth rate during each year of life?

(4) What is the length of larval life?

(5) How do the spawning seasons of competitors for setting space compare with oysters?

(6) What are the optimum eclogical conditions. What extremes of salinity, temperature, etc., can be tolerated by larvae and adults?

In order to answer these questions a broad research program has been started with the center of activity located in Apalachicola Bay. A field laboratory has been set up and equipped in one of the local seafood houses. Nine stations have been established at which fall of spat, salinity temperature, turbidity and other hydrographic data are obtained each week. In addition, growth rate of young spa is being studied and at two of the stations

the growth rate of larger size oysters is being carefully watched.

A weather station is located in Apalachicola which enables us to correlate facts obtained from the nine stations with meteorological finds such as air temperature, wind direction and intensity, precipitation.

Meteorological data for a period of thirty-five years is available to us in judging the normaley of the weather during the investigation and, hence, whether or not the findings of the investigations can be deemed typical.

In addition the U. S. Weather Bureau, maintains a river station at Blounstown, fifty miles up the Apalachicola River from the site of the investigation. Accurate data is obtainable from this station on flood stages, rate of fresh water discharge.

Thus we can surround our studies of oyster biology, especially spawning, by quantitative data on a great number of physical and chemical environmental factors, even to the amount of sunshine received by Apalachicola Bay.

This information, as it is received, is translated into constructive measures for the rehabilitation of the oyster bottoms. For instance, the discovery that spawning occurred much earlier than was anticipated has enabled us to beging the planting of cultch at an early date with the assurance that it would attract a substantial number of oyster spat.

Also, since spawning occurs in a greater density in different parts of the bay at separate time we are able to adapt our cultch planting operations to the areas which enjoy an intensified spawning during any particular week or month.

Coorelative studies are being carried out on a smaller scale in Cedar Key, Florida, a location at some distance from Apalachicola on the west coast of the State of a latitude of about 60 miles more southerly. It is expected that there might be slight differences in spawning habits of the oysters of this region due to greater temperatures on an overall, year around basis, although this contention remains to be proven. Several experimental plots of seed oysters have been planted in the waters south of the Suwanee River to ascertain which of these areas hold the greatest potentialities for oyster culture.

It will be interesting from an academic standpoint to compare the findings of this investigation with the knowledge already available on the same animal in other parts of the United States and Canada.

But more important will be the help these facts will provide in actual cultivation. In February 1949 there were only 1738 acres of oyster bottoms leased to private concerns. By consultation with interested planters and by encouragement it is hoped that this acreage can be doubled within the next year.

Closed seasons, management, (including the planting of cultch) and close observation are expected to increase the yield from natural bars.

INTENSITY AND DISTRIBUTION OF OYSTER SET IN CHESAPEAKE BAY AND TRIBUTARIES

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The intensity and distribution of the commercial oyster set in the Chesapeake Bay and its tributaries has been studied for some years now by biologists of the Department of Research and Education at Solomons, the Fish and Wildlife Service and recently by the Virginia Fisheries Laboratory. Setting of previous years has been reported at these meetings thus only the 1947 and 1948 oyster set will be described. Obviously it is important to know what number of spat has set, so that future production plans may be formulated both for seed and marketable oysters. For the purpose of this report, the Maryland part of the Chesapeake Bay is divided into three distinct areas, each having its own particular characteristics. These areas may be defined as follows: The Upper Bay is that portion lying above Sandy Point on the Western Shore and Love Point on the Eastern Shore. The lower part of the Chesapeake Bay is divided by the ship channel into the western and eastern half. These two are quite different in their physical characteristics. The Main tributaries of the bay react as individual units and will be treated as such. The seed areas are sharply defined and have certain distinct characteristics which will be described later.

Very detailed observations are being taken on each oyster bar visited and a standard form filled in by the biologists of the several agencies working in the field. These forms have been developed jointly and all the groups working in the Chesapeake area are making uniform observations, so that information obtained in different areas can be compared accurately. In this way, there is being built up records of actual populations and the physical characteristics of the oyster bars.

Many areas are visited but once a year, so that it is important to have as complete a picture as can be made at that time. Other areas, notably seed areas, are under intensive observation and detailed information obtained at frequent intervals is available. These will be discussed in some detail later in this report.

The counts of oyster spat used in this report were made on one half bushel random samples from the oyster bar. Usually several samples were taken on each bar and the counts averaged.

Most of the Chesapeake Bay bars show a remarkably poor setting record for both 1947 and 1948. However, if the record is broken down according to areas, it will be seen that one area, the eastern shore of the Bay from Love Point to Tangier Sound had a rather consistent setting record. Several areas along this shore show setting characteristics comparable to seed areas. One such area in 1948 had a set of 743 spat per bushel on natural cultch.

The figure used in the following averages were derived by averaging only bars which were visited both in 1947 and 1948.

The average set on the eastern shore side of the Bay for 1947 was 61.2 spat per bushel and for 1948 was 15.5 spat per bushel. This figure does not include the two high setting areas visited in 1948. These counts are too low to make good self-sustaining bars. The western shore of the Bay has an even lower setting record. The average set on bars visited in both years showed a setting average of only 2.2 spat per bushel in 1947 and 3.4 spat per bushel in 1948.

The upper part of the Bay in which ten bars were visited both years showed in 1947 an average set of 5.5 spat per bushel. In 1948 this figure dropped to 0.3 spat per bushel. These figures show that the future populations of the upper and western parts of the Chesapeake Bay, barring an unusually heavy set, will be of practically no commercial value. This low setting rate combined with the low population level presents a very poor outlook for the near future of public oystering in the Bay proper. The bars mentioned are all Bay dredging bars.

In general, the 1948 setting record was even lower than the 1947 set, possibly reflecting the general lowering of the population level.

The picture in the tributaries is not good, but it is materially better in most cases than in the Bay proper. One of the large producing tributaries is the Choptank River. This area has in the past been largely self-sustaining but the population level is being gradually lowered. In 1947, the average number of spat per bushel was 28. In 1948 this figure fell to 9 spat per bushel. This set will not add materially to the production of the river. The tributaries of the Choptank are, however, rather heavy setting areas and can be expected to continue to produce.

Tangier Sound, one of the important producing areas, still has a good population of market oysters. These oysters are predominantly of the 1945 set which was excellent. This area in 1947, excluding the seed area of Holland Straits, has an average surviving set of 45 spat per bushel. In 1948, the set was slightly higher averaging 55 spat per bushel. Tangier Sound has many very excellent tributaries which are heavy oyster producing

areas and which may contribute materially to the set in the Sound. These tributaries receive good oyster sets each year and are good self-sustaining areas.

Pocomoke Sound, a fine self-sustaining area, showed a great drop in spat per bushel setting in 1948. In 1947, the record was 308 spat per bushel on natural cultch and in 1948 it was 197 spat per bushel. There is, however, an excellent population of oysters on the small area of natural rocks.

The Potomac River, excluding the tributaries, presents a rather discouraging picture as the population level is low on nearly all the major bars and it has received a very poor set during the last two years. In 1947, the average set was 10.8 spat per bushel and in 1948 the average set was only 7 per bushel. The tributaries of the Potomac River, however, present an entirely different situation. Excluding the St. Mary's seed area, the average set in the tributaries was 178 spat per bushel in 1947 and 86 spat per bushel in 1948. These records, again, cover producing bars and not shell plantings. However, there was a drop in 1948 almost proportional to the drop in setting in the Potomac River.

The Patuxent River, typically a poor setting area, continued its record of low setting with an average in 1947 of 15 spat per bushel. In 1948, the set was even lower, being 7 spat per bushel. Unlike some of the rivers, the Patuxent lacks oyster producing tributaries. The Patuxent must depend on plantings of seed oysters from the State's seed areas to maintain its bars in production. There is a low level of marketable oyster present in the population now, so the outlook is not bright for next year.

The three main seed areas of Maryland bear a rather striking resemblance in many of their physical characteristics. They are all nearly land-locked, have heavy populations of adult oysters and typically are not deep. There are many smaller potential seed areas which have not been developed and utilized but which are now excellent self-sustaining areas.

Eastern Bay is perhaps the largest potential seed area in the state. At this time only a fraction of its acreage is being used for seed purposes. It has a consistent record of heavy setting. Close study of this area is being made by the Fish and Wildlife Service. Examination of the shells planted there disclosed that the surviving set was 2002 spat per bushel in the fall of 1947. In 1948, the catch was lower, being 776 spat to the bushel on planted shells. Slag which has been planted as cultch in the Eastern Bay seed area for several years was found in 1947 to have a surviving set of 2280 spat per bushel. The 1948 planting of slag had a set of 944 spat per bushel. These counts are higher than those

on planted shells in the same area. There is however, a higher mortality in moving the spat on slag than there is in moving the spat on shells, due to the rolling of the particles of slag in the dredge which crushes the small spat. The natural oysters bars in the Eastern Bay area annually receive a good catch of spat. This area probably will be used more in the future by the State as a seed area.

Holland Straits is a large area which is not fully developed at present. It has had a somewhat more spotty setting record than Eastern Bay, but it is a good seed area. The last two years were below average in spat per bushel. In 1947, the surviving set was 153 spat per bushel and in 1948 the set was 408 spat per bushel. There is a possibility that too much brood stock is being removed and that an area should be established in which the oysters would be left to mature and breed. Such a sanctuary might, it appears, increase the average set materially. This area will be studied more closely during the coming setting season.

The area which has been studied most intensively by the Chesapeake Biological Laboratory is the St. Mary's River, a tributary of the Potomac River. This river has a consistently good setting record, but there is not a very large area available for development. The area here is much less than that available either in Holland Straits or Eastern Bay. There is an abundance of adult oysters on it which do not grow to a large size becuase, presumably, of overcrowding. The average surviving set in the St. Mary's River seed area on planted shells in 1947 was 1807 spat per bushel. This figure in 1948 feel to 788 spat per bushel. The natural bars in the river also receive a good catch of spat. Many types of experimental cultch have been tried here, including slag of three different sizes, tin scrap, broken plaster molds and porcelain insulators. Also, intensive observations of oyster setting and of fouling organisms have been carried on from June until September and weekly records of salinity and temperature have been taken.

This concludes an area by area analysis of the distribution and intensity of setting in Maryland waters of the Chesapeake Bay for 1947-1948. The year 1948 was below average for setting in most cases and in almost all cases

was below 1947 in average set of spat. As can be seen from the foregoing report, the need in Maryland is to develop the seed areas to a point where we can begin to build up the population on the now barren natural oyster bottom. The population level in the Bay proper and in many of the western shore tributaries, has reached a point where it now appears unlikely that they will return to a commercial level of production under natural conditions in this generation.

ON THE CULTURE OF OYSTER LARVAE IN THE LABORATORY

-by-
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In a study of the effects of the various conditions which the oyster larvae may encounter in nature, it is desirable to be able to maintain cultures of the larvae in the laboratory during as many months of the years as possible. Observations on these cultures will undoubtedly reveal many of the conditions responsible for the death of larvae in nature and may finally explain why the oyster set is a complete failure in certain localities in some years.

Using methods developed at Milford Laboratory for inducing gonad development out of season, it is now possible to obtain larvae almost throughout the year. During the last year larvae have been reared to the setting stage not only in summer but also in winter getting sets as high as several hundred spat per 16 liter (approximately 4.2 gallon) culture jar at either season.

The standard method for rearing oyster larvae has previously been described in detail. Briefly, it consists of changing the sea water in the culture jars, every second day, through stainless steel screens that retain the larvae. The cultures are constantly aerated and supplementary food is added daily. Our experience indicates that this offers the larvae the best conditions attainable, at the present time, in the laboratory. When more frequent changes have been made, except in rare instances, no improvement has been noted either in rate of growth or in survival of the larvae. They do not do as well if changed less frequently however, probably an accumulation of waste products causes the slower rate of growth and poorer survival of larvae noted in these cases.

In using the methods for inducing gonad development out of season and rearing larvae in the laboratory abnormal larvae were occasionally encountered. Some of these abnormal larvae were apparently due to immature eggs, obtained by induced abortive spawnings of females that were not fully ripe. In some cases such spawnings appeared to be quite normal and large quantities of eggs were released, more frequently, however, comparatively few eggs were released. If, for example, oysters were spawned after relatively short conditioning periods at temperatures only slightly above 20.0°C., the eggs sometimes developed only to the late gastrula or early trochophore stages. At these stages they became so "sticky" that they adhered to each other and to the walls of the culture jar, particularly at the water line where they normally congregate in large numbers. After 24 hours in such a culture, a gummy ring was found at the water line and all the larvae were dead. With somewhat more advanced but still immature eggs, the larvae developed

shells more or less normally but were quite small measuring only 60 to 70μ at the 48-hour straight hinge stage.

A situation, which may have a similar explantion, was encountered with oysters from the natural beds in Milford Harbor and Long Island Sound in the summer of 1948. During the period of July 5-15 five groups of oysters from these beds were spawned with none of the five batches of spawn collected giving more than few very small straight hinge larvae, even though on July 1st and 2nd similar groups of oysters had been brought into the laboratory and spawned and the resulting larvae developed normally. Also on July 19 some of the oysters of the July 15 group spawned again and these larvae developed normally. Probably most of the oysters involved had spawned on the natural beds just prior to being brought in and possibly at the time of their first spawning in the laboratory had not again accumulated fully mature eggs.

Overcrowding the larvae in the culture jars may also result in abnormal larvae. In most cultures that contained 500 or more eggs per cubic centimeter, if the larvae developed to the shelled stages at all, the shells formed were abnormal and the larvae soon died. In some cases, however, using daily changes of water and the addition of large quantities of supplemental food, such cultures have been carried for 15 days and more, and the larvae have shown some growth.

Another possible cause of abnormal larvae is the use of sea water in which adult oysters have been kept. Eggs collected from the conditioning tanks and trays after a mass spawning usually gave a poor percentage of shelled larvae many of which were abnormal in shape. Fewer abnormal larvae are obtained when large numbers of eggs are spawned in a small vessel so that the sea water containing the eggs can be greatly diluted with fresh sea water in preparing the cultures. Parallel cultures, one of which was diluted with fresh sea water, while the other was diluted with water from an aquarium in which adult oysters were being conditioned, showed that the sea water in which adult oysters had been kept gave a much lower percentage of shelled larvae and many of them were abnormal in shape.

Regardless of the cause of the abnormality, such larvae rarely grow satisfactorily, even though the conditions causing it are later corrected and the larvae may live for several days.

Healthy larvae, however, appear to be quite hardy and capable of withstanding many of the temporary changes in the physical conditions they are

Healthy larvae, however, appear to be quite hardy and capable of withstanding many of the temporary changes in the physical conditions they are likely to encounter in natural waters. While our laboratory cultures that show the best growth are those constantly kept at temperatures of 21.0° to 23.0°C., nevertheless, oyster larvae have lived for periods up to 33 days and grown, even when subjected every 48 hours to a sharp drop from 20.0°C., to temperatures of 8.0 or 10.0° C., for periods of 15 to 30 minutes followed by an equally abrupt rise in temperature back to 20.0°C. In fact some of these larvae lived and later set after being returned to constant temperature conditions at 21.0° to 23.0° C. It would seem unlikely, therefore, that the ordinary fluctuations in temperature occurring in natural waters could directly account for any appreciable mortality of larvae. Loosanoff and Engle (1940) in their study of spawning and setting in Long Island Sound observed that larvae lived and set at temperatures ranging from 16.6° to 28.0° C., and likewise concluded that oyster larvae can withstand rather drastic changes in temperature.

Larvae are also apparently able to tolerate very low dissolved oxygen values, at least for short periods. For example, on one occasion a number of healthy larvae was accidentally left overnight in a small pipette of sea water, yet these larvae were found to be alive and healthy next morning although the oxygen content of the water must have been almost completely exhausted.

In another case a large oyster larva of setting size failed to get washed from a screen during a change of sea water only to be found alive and healthy after a six-hour exposure to air.

There is considerable evidence, however, that larvae of our Eastern oyster, _Ostrea virginica_, do not utilize as wide a variety of foods as do larvae of the hard clam, _Venus mercenaria_, or the Olympia oyster, _Ostrea lurida_, and that food is the limiting factor in the growth of our oyster larvae, at least in laboratory cultures.

Although an occasional culture of our Eastern oyster larvae has been grown to the setting stage without supplemental food, in no case have we been able to get larvae of the hard clam to grow under similar conditions. Nevertheless, any of several mixed plankton cultures serves quite well as supplemental food for clam larvae, while with oyster larvae, on the other hand, only occasionally have we been able to get a mixture that the early larvae can utilize. It is interesting that none of the pure cultures of green flagellates, colorless flagellates, or algae tried to date has given as good a rate of growth with either oyster or clam larvae, as do the mixed cultures.

That clam larvae do utilize foods that the oyster larvae cannot has been demonstrated by mixed cultures of clam and oyster larvae in which their living conditions must be the same. Supplemental foods were used that permitted the clam larvae to grow normally and set in the regular 12 to 14-day period. The oyster larvae, however, grew very little or not at all, and eventually died. These results were not due to the clam larvae, which are larger, robbing the oyster larvae of food since the results were the same even when only a half dozen or so clam larvae were present in the mixture. Similar results were also obtained using parallel cultures of clam and oyster larvae that received the same food.

The fact that cultures of clam larvae can regularly be reared to the setting stage, while many of our cultures of Eastern oyster larvae cannot appear to be due solely to the ability of the clam larvae to utilize a much wider variety of supplemental foods.

Likewise, larvae of our Eastern oyster cannot utilize foods that larvae of the Olympia oyster can use. Cultures of the Olympia larvae have been reared to the setting stage, while parallel cultures of our Long Island Sound larvae receiving the same food grew very slowly, with one culture all dead in 10 days, the second culture almost all dead at 15 days and the remaining culture showing a very wide range of sizes, from 75μ straight hinge larvae to medium umbo stages, by the time the Olympia larvae set.

In laboratory cultures, at least, food seems to be the limiting factor in the growth of oyster larvae. While occasional cultures have been reared to the setting stage merely by changing the sea water every 48 hours, throughout most of the year supplemental feeding is ncessary.

Evidence that it is lack of food that limits the growth in our cultures of oyster larvae was obtained from parallel cultures one of which received supplemental food while the other did not. Most of the cultures in which the larvae reached the setting stage were those that received supplemental food, and in most cases larvae in the parallel unfed cultures grew very little and eventually all died. In many cases, of course, both cultures grew very little and died in about 10 days, apparently becuase the supplemental foods used in those cases were not utilizable by the oyster larvae.

Another indication that it is lack of proper food that prevents many of our cultures of oyster larvae from growing is that it is possible to duplicate, with clam larvae, the slow rate of growth, wide variations in size and high mortality, so characteristic of many

of the cultures of oyster larvae, merely by supplying insufficient quantities or the wrong type of food to the clam larvae.

Finally, it is difficult to conceive any other factor than lack of proper food that would so prolong the free-swimming period of our Eastern oyster larvae while by using the same techniques hard clam larvae and Olympia oyster larvae are regularly reared to the setting stage in relatively normal time. Although in one experiment our Eastern oyster larvae were reared to the setting stage in 23 days, in most cases it required 36 to 40 days for the larvae to reach the setting stage, and in a culture from eggs spawned January 6 it required 50 days for the first larva to reach the setting stage, the most profuse setting was between the 52nd and 54th days and some setting continued until the 60th day.

Two conclusions, therefore, seem warranted - first, that our Eastern oyster larvae are not able to utilize as wide a variety of foods as can the larvae of the hard clam or the Olympia oyster, and second, that it is food, at least in laboratory cultures, that is the limiting factor in growth of oyster larvae.

Preliminary experiments are in progress to explore the possibilities of interspecific hybridization. On several occasions active Olympia sperm have been added to unfertilized eggs of our Long Island Sound oysters but fertilization did not occur. Such eggs held for as long as eight hours showed no evidence of fertilization. In some instances active sperm from our Eastern oysters were added two or more hours after the addition of the Olympia sperm and in such cases fertilization by the Eastern oyster sperm and the subsequent development of the eggs was equally as good as for unfertilized control eggs held for similar periods before the addition of Eastern sperm. The Olympia sperm, therefore, probably does not even enter the egg of our Long Island Sound oyster since it does not cause the formation of a fertilization membrane nor does it interfere in any way with the fertilization by Eastern oyster sperm.

Although crosses have been made between the Eastern oyster and the Japanese oyster, _Ostrea gigas_, and between the Eastern oyster and the Kumamoto oyster (probably a variety of O. gigas) and reciprocal fertilization is obtained, no conclusions can be drawn as to the viability of the resulting larvae. The adult Japanese and Kumamoto oysters were shipped to us from the State of Washington in the fall and apparently had not spawned in the Washington waters last summer since all were found to contain large quantities of spawn. Although some of these oysters were induced to spawn and their eggs and sperm used in the crosses, we are in some doubt that such spawn was normal. Hence, in

those cases where the larvae did not live, it remained undetermined whether it was an incompatibility of sexual products or simply the poor condition of the held-over spawn that caused the mortality. Even at the present time many of these oysters have not yet resorbed the old spawn and so cannot be induced to develop new gonads.

S U M M A R Y

It is now possible to obtain oyster larvae, in the laboratory, throughout most of the year and to rear the larvae to the setting stage both in winter and in summer.

In general, healthy larvae are quite hardy and can withstand at least temporary exposure to such conditions as low temperatures, low oxygen content of the sea water, and even exposure to short periods of drying.

It appears, however, that food is the limiting factor in the laboratory culture of oyster larvae and that supplementary feeding is required during most of the year. The ability to supply the proper food determines the success of rearing them in the laboratory. That larvae of the Eastern oyster, _Ostrea virginica_, are unable to utilize foods that some other larvae can use has been shown by comparative feeding experiments.

Preliminary studies to explore the possibilities of interspecific hybridization show that the Olympia oyster, _Ostrea lurida_, will not cross with the Eastern oyster but that the Japanese and Kumamoto oysters (varieties of _Ostrea gigas_) are capable of reciprocal fertilization with the Eastern oyster. Tests of the viability of the larvae from these latter crosses have not been concluded.

THE OYSTER INDUSTRY OF NORTH CAROLINA AND SOME OF ITS PROBLEMS.

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According to the available statistics, North Carolina has maintained a rather modest position in oyster production over the past fifty years. In 1940, for example, it was third or fourth from the bottom of the list of oyster-producing states along the Atlantic and Gulf coasts. Since 1930 production has only twice exceeded 500,000 bushels in a single season. At least four surveys have been made of North Carolina waters concerning the possibilities of oyster culture (Winslow, 1886; Grave, 1904; Coker, 1907; Galtsoff and Seiwell, 1928). Each survey appears to express the opinion that potentialities exist for a great industry. However, the industry has been slow to develop, and the oyster continues to represent one of the great undeveloped natural resources of the state.

The oyster-producing areas are located in the numerous sounds of the state, bound on the ocean side by the so-called "banks", making these sounds almost landlocked bodies of water. Albemarle and Currituck Sounds are considered too fresh for oysters. Oysters are found growing from Roanoke Island to the South Carolina border. Pamlico Sound produces the bulk of the oysters marketed in the state. This is not surprising when we consider that this body of water with approximately 1, 100,000 acres is seven times greater than Roanoke, Croatan, Bogue and Core Sounds combined. Pamlico Sound, some seventy miles long by thirty miles wide at its greatest length and breadth, is a relatively shallow body of water averaging 18 feet in depth, with the greatest depth at 25 feet. Several shoals extend from the mainland into the sound. Brant Island Shoal with a depth of 2 to 8 feet extends in a northwest-southeast direction about half way across the sound. Bluff Shoal extends in a north-south direction from the northern shore of Pamlico Sound with a depth of 7 to 11 feet overlying the shoal. It merges into Royal Shoal which extends to Ocracoke Inlet. The bottom of Pamlico Sound varies from mud to hard sand with the mud bottom confined chiefly to the channels of the various tributaries. The salinity in the immediate vicinity of the inlets averages about 30 parts per thousand, progressively diminishing toward the mouths of the Pamlico and Neuse Rivers on the western side of the sound. The currents are determined largely by the winds, and the tidal fluctuations are found in the vicinity of the inlets.

Winslow (1886) estimated 10,000 acres of natural beds for the state with 7,700 acres located in Pamlico Sound. Ten years after Winslow's survey, extensive beds were discovered in Pamlico Sound about two miles off shore in deeper water. Grave (1904) states that some beds surveyed by Winslow in Hyde County had increased in area due to extensive dredging and estimated the natural beds in this county from 18,000 to 36,000 acres in 1900. No recent surveys have been made, but many of the areas surveyed by Winslow were found this past year to be productive. Occasional reports are received from shrimp trawlers that beds are located in the lower south-east Pamlico Sound Area. A survey is planned of this area in the near future.

The oyster industry of North Carolina became of importance in 1889 when decreased oyster production in the Chesapeake region led to the establishment of branch houses in the coastal areas. It is of interest that the oysters processed at the time were shipped to Baltimore and sold as Chesapeake oysters. This still exists at the present day. Many oysters are shucked, packed and reshipped by Chesapeake dealers.

Within the past few decades some changes have occurred in the area. The hurricane of 1933 opened twenty-eight inlets between Beaufort and Ocracoke Inlets and completely ruined the oyster beds at Harbor Island. Most of the new inlets have closed except Drum Inlet. The salinity in the vicinity of Drum Inlet has increased to over 30 parts per thousand as compared to an average of 23 parts per thousand reported by Galtsoff and Seiwell (1928). Clams are now abundant in an area where oysters were produced in marketable quantities.

More oysters are being shipped out from shucking houses instead of in the shell. Since 1946 at least 35 new shucking houses have been constructed. These are modest but clean, efficient plants, a marked contrast to the sheds of past years. According to Mr. Caldwell, chief sanitarian, the trend has been toward smaller plants located as near as possible to the oyster-producing areas, instead of larger houses near a railroad center. This past season there were 63 shucking houses in the state, with 28 certified for inter-state shipping. Twenty-five shucking houses are located in the Pamlico Sound area. Two steam canneries operated last season, utilizing the "coon" oysters from the Baufort Inlet area.

Regulations requiring dredging with sail power and limitations on sizes of vessels were repealed in 1948. Heretofore, vessels over 32 feet in length were required to dredge with sails.

The legislature of 1947, upon the recommendation of a committee appointed by Governor Cherry, passed a law imposing a tax of 50¢ on every bushel of oysters going out of the state in the shell. Attempts to repeal this measure were defeated during the 1949 session. Opponents of the tax believe that North Carolina could be developed into an important seed-producing area and believe that such a tax is hindering this program. There are areas where an abundance of seed could be procured in Bogue, Core and Pamlico Sounds. A question arises whether the available seed be used within the state to maintain and encourage the industry or be allowed to leave the state. There may be sufficient for both purposes. The legislature of 1947 also passed a regulation specifying the return of 50 percent of the shells accumulating at the shucking houses, thus inaugurating a definite shell-planting program. A tax on oysters harvested from the natural beds was increased from 4 to 8¢ per bushel. The increased revenue is to aid in meeting the expenses of shell plantings. In 1947, 63,258 bushels of shells were planted. In 1948, this amount was increased to 95,919 bushels. In 1949, 119,517 bushels of shells were planted as the state's quota with an additional 34,000 bushels of shell purchased. Ten thousand bushels of seed oysters were transplanted as an experimental procedure in three counties.

The private leasing of grounds for oyster culture has been emphasized since the time of Winslow's survey in 1886. This supposed solution to the problem of increased oyster production and development of the industry has not been too popular. Leasing of bottom is permitted within the state with limits of 50 acres in the tributaries and 200 acres in Pamlico Sound. However, the counties of Hyde and Pamlico prohibit leasing of bottom. There are at present but 3,232 acres under lease. The majority of these grounds average ten acres and are used to raise oysters for family use or to supply oyster roasts. These leased areas are found chiefly in the tributaries of Core and Bogue Sounds.

Many factors appear to favor North Carolina as an oyster-producing area. There is an abundance of seed in some areas. Potentialities exist in Core and Bogue Sounds for greater utilization and development of oyster seed. The quality of oysters is, in general, good and can compare favorably with oysters from other areas. The fact that North Carolina oysters have since 1890 been sold as Chesapeake oysters cannot be overlooked. North Carolina is situated about in the geographical center of the extreme ranges of the eastern oyster. Weather conditions favor rapid growth, making it possible, in some localities, to produce a marketable oyster in two years. The numbers of enemies are not as great as in other oyster-producing areas; Pamlico Sound is

virtually free of predatory enemies. The boring sponge, Cliona, does not cause damage to oysters in North and New Rivers. In the upper regions of Middle Bay and Caffee Bay the shells of all oysters examined, over two years old, were heavily riddled with sponge. Polydora is prevalent in widely separated localities with heavy infestations in the oysters growing on the shoals at Ocracoke Inlet. Mussels (*Mytilus recurvus*)cover oyster to form large masses in the head of Jones Bay, Swanquarter Bay and other localities. Industrial and domestic pollution are of minor consequent in Pamlico Sound. Over 27,000 acres of shellfish-producing area were restricted in North Carolina because of pollution during the 1948-49 season. However, there were no areas closed in Pamlico Sound during the same season due to pollution.

The Institute of Fisheries Research is acting in an advisory capacity to the North Carolina Department of Conservation and Development in the rehabilitation and development of the industry.

GROWTH OBSERVATIONS OF OYSTERS HELD ON TRAYS AT SOLOMONS ISLAND, MARYLAND

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It is a common observation that oysters growing on different bars may differ widely in rate of growth. Deepness of the cupped shell, ratio of length to width, and general appearance also may differ markedly. The reasons for slow rates of growth are not always apparent. On some of Maryland's seed areas, few oysters reach legal size even when six or more years old. This condition might be attributed to crowding. However, the most rapid growth observed in Maryland's portion of the Chesapeake area occurred in upper Pocomoke Sound where a very heavy set on shell plants produced many individuals around 3 inches in length by late fall of the year when they set, and numerous 6 inch oysters by the second fall. Crowding caused these oysters to be rather elongated but they had good meats with shells so thin they often broke in two at the muscle when shucking. The slow growth characteristic of oysters on the Head of the Bay bars probably results largely from frequent periods of low salinity when little if any feeding activity occurs. It is difficult, however, to correlate a higher rate of growth with increased salinity. In Chincoteague Bay, where salinities normally are just under 30°/00, growth was extremely poor in 1945 and exceptionally fast during 1948-49.

Numerous measurements of State transplanted seed were made from 1943 to 1946 using random samples of about 400 individuals. Seed from St. Mary's River transplanted to the upper Patuxent increased from a length of 28 mm. in April, 1944 to 83 mm. in October 1945 when the bar was opened, a gain in length of 196%. Holland Straits seed planted in three different bars in Tangier Sound all grew rather uniformly with an increase from 36 mm. in April 1944, to about 69 mm. in September 1945, a gain in length of only 92%. Yearling seed oysters grew 151% faster in length in the Upper Patuxent River than in Chincoteague Bay during 1944-45, but grew 26% faster in Chincoteague Bay than on a mid-Patuxent River bar during 1946. Similar wide variations have been observed among other State planted bars where growth of the seed was followed. Obviously varying environmental conditions play a very important part in the growth and condition of oysters. Among the factors which may influence growth are variations in salinity, temperature, turbidity, species of food organisms, abundance of food organisms, current flow, bottom texture, toxic organisms such as those producing the red tide, organisms competing for food, or-

ganisms competing for food, organisms competing for space, pollution, natural decomposition products and others.

Oyster planters often report that seed from one area will grow faster than that from another and that survival also may vary. Dr. Nelson has postulated that enforcement of a three inch cull law may tend to produce a slower growing race of oysters by returning the runts or "dumpy" oysters to the bars where they form an increasingly higher proportion of the brood stock. Dr. Korringa has stated that the Dutch have produced a faster growing oyster in Holland than the same species grown along the coast of France by putting back the faster growing individuals as brood stock. In areas of intensive setting such as along the Gulf, portions of the South Atlantic Coast, and certain seed areas further north, the older oysters are quickly covered over and smothered out by the younger set with only the fastest growing individuals able to survive. Such conditions would seem favorable to a natural selection of a quick growing race of oysters.

Observations of growth on various plantings such as the ones previously quoted are so influenced by environmental factors that it is difficult if not impossible to evaluate the effect of any inherent tendency towards a rapid or slow rate of growth. Measurement by random sampling of a planting may have considerable error and possesses the further disadvantage that a given group or year class tends to lose its identity after the second year. By following the growth of the same individuals held on a tray, or identified in some other manner, a much more accurate record of growth and mortality may be obtained. This method has been followed by a number of observers. Dr. Loosanoff measured the length, width, depth and volume of marked groups of oysters and determined the decreasing rate of growth with age under conditions prevailing in Long Island Sound at the time of the experiments. (Southern Fisherman, January, 1947). He later compared the survival and growth of Maryland Eastern Bay seed with the native Long Island Stock and reported that the Maryland set grow somewhat slower but survived better than the natives, (Oyster Institute Bulletin, February 7, 1949).

In an attempt to throw additional light on the question of whether or not oysters from certain areas may possess inherent characteristics favoring their growth and survival under given conditions, batches of oysters from various areas were planted at Solomons under as nearly the same environmental conditions as practicable. During early observations, difference in survival and growth can be expected to occur as a result of the extent to which the oysters must become adjusted to a different environment. Data accumulated over a number of years, however, should afford an indication as to the presence and extent of inherent characteristics. Practical

value of the results of such observations lies in the designation of those seed sources from which oysters do best when transplanted to typical Maryland conditions. If seed from certain areas should show superior growth and survival characteristics then effort can be made to establish them as brook stock in the state seed producing areas.

All oysters in these experiments have been grown on trays of the Sea Rac type placed on the bottom under the Laboratory pier in the Patuxent River. Depth of water over the trays is about four feet, the trays being placed side by side in a line extending at right angles to the shore and with a comparatively weak tidal current flowing across them. All oysters were placed by hand at a slight angle leaning on the left valve with the bills up. This position insures a uniform exposure but seems to have produced a somewhat more elongate oyster than those grown flat down on the left valve. Tidal amplitude averages 1.2 feet and salinity approximately $14^{o}/oo$ varying from a normal of about 11 in late spring to 16.5 in the fall. Considerable variations from normal may occur from year to year.

The initial plantings consisted of groups of 500 oysters divided between two trays. Later plantings have employed somewhat smaller numbers. Each tray had 2 x 4 timbers wired to its bottom to prevent settling. These timbers were abandoned after the first year since it was found that they were destroyed by shipworms in one season and no apparent difference resulted from resting the trays directly on the bottom. Measurements of the length and width of each oyster were made, usually at bi-monthly intervals. Depth was not measured because the difficulty encountered with fouling organisms and erosion of the shell made it impractical to attain sufficient accuracy where so many animals are measured. Boxes were measured and a correction for their size was applied to the preceding measurement since it was observed that typically those which died had made little or no recent growth. Occasionally a few individuals disappeared from the trays and could not be accounted for. The series under observation was added to in 1948 and again in 1949. Similar plantings have been started in a prong of the Maryland portion of Chincoteague Bay.

Growth and mortality curves for the various groups have been plotted. The patterns of growth at Solomons during 1947, 1948 and the spring of 1949 have been somewhat different. Growth during the spring of 1947 was good but levelled off with little or no growth occurring during July and August. Rapid fall growth followed. The interval between late fall and early spring measurements was too great to show any cessation of growth during the winter months. Growth during the spring of 1948 was again rapid and of an

open frilly nature with the thin growing edges somewhat reflexed. This growth period was followed by an upturn in mortality particularly among one group of local seed. During the summer months much of this growth eroded away so that the oysters generally dropped back in both length and width. Very good fall growth then followed and continued through December. During January and February of 1949, a moderate recession in growth again occurred. This spring the new growing edge or bill remained back within a fold of the old growth so that the overall measurements up to early May had failed to increase and in some cases dropped back slightly. The oysters, however, were in good condition and the new growing edge was about even with the margin of the older growth.

Ratio of length to width of tray grown oysters has tended to approach 1.5 with young round shaped oysters showing an increasing, and long coon-type oysters a decreasing ratio. In comparing the groups, the product of the length in millimeters times the width in millimeters was selected as the most satisfactory index of growth from the available data. For the purposes of this paper detailed growth during the year will not be shown.

Table 1 gives the late spring, early fall and winter length measurements of selected groups of seed. It compares two groups of similar size composition which show the more marked differences in growth. These also illustrate the greater fall growth as compared with spring growth, the very poor summer growth of 1948 and the lack of growth this spring. Average length by age groups is quite similar to that given by Loosanoff for Long Island Sound.

To illustrate that environmental and seasonal differences may affect growth to a much greater extent than is apparent between the different groups growing together at Solomons, the lengths of oysters in a tray planting in Chincoteague Bay and in an older seed planting in the Patuxent River are given.

TABLE 1

LENGTH IN MM. OF TRAY GROWN SEED

Source	Dominant year class	May '47	Sept. '47	Winter	May '48	Sept. '48	Winter	May '49
(Holland Straits	1945-46	46	55	70	73	75	84	85)
(Maurice River	1945	48	53	65	68	68	73	72)
(Gull Rock	1944-45	67	71	84	86	86	92	92)
(Mullica River	1944-45	67	67	77	79	79	83	83)
Fishing Bay	1945 planted in Chincoteague Bay				73	102	112	118

LENGTH IN MM. OF RANDOM SAMPLES
OF PATUXENT PLANTING

Seed from shell plants in	Year class	April '44	July '44	Dec. '44	July '45	Oct. '45
St. Mary's River	1943	27	43	71	74	83

(marketed in 3rd year)

Tables 2 and 3 show the growth of all groups started on trays in 1947 and 1948 as indicated by the product of length and width for one year periods. The cumulative per cent of mortality observed is also given. It will be noted that the mortality of established oysters during the second year is less than during the initial year. Higher mortality generally occurred among oysters transplanted from waters of greater salinity and among those of the smaller sizes. The best survival at Solomons, 5% mortality, has been among Gull Rock, N. C., seed, which were of comparatively large size and from water subject to periods of fairly low salinity. The greatest mortality, 58.4% was among the Long Island Sound Oysters from waters of a comparatively high and stable salinity. The seed transplanted from Chesapeake salinities of around 12 to a portion of Chincoteague Bay, where salinities range from 20to 30 have shown better survival and growth than any of those planted at Solomons.

TABLE 2
GROWTH AND MORTALITY OF SEED OYSTERS
PLANTED AT SOLOMONS IN MAY, 1947:
SIZE EXPRESSED AS MM. LENGTH X MM. WIDTH

Source of Seed	Initial Size	Size in 1 year	% Mort. 1 year	Size in 2 years	% Mort. 2 years
Gull Rock, N. C.	2993	5047	2.8	5450	5.0
Mullica River, N. J.	2846	4289	7.0	4442	12.6
Milford, Conn.	2745	4599	40.8	4701	58.4
St. Mary's River, Md.	2623	4327	22.8	5236	26.2
James River, Va.	2594	4230	9.8	4410	13.4
Delaware River, N.J.	2094	3625	14.0	3982	23.2
Maurice River, N. J.	1649	3261	16.4	3484	20.4
Holland Straits, Md.	1584	3793	6.2	4901	15.0
Eastern Bay, Md.	1348	3410	15.4	4339	17.4

TABLE 3

GROWTH AND MORTALITY OF SEED OYSTERS
PLANTED AT SOLOMONS IN APRIL-MAY, 1948

Source of Seed	Initial Size	Size in 1 year	% Mortality 1 year
New Haven, Conn.	3673	4095	27.6
Edisto River, S. C.	2954	3566	14.9
Green Point, L. I.	2834	3575	37.0
New River, N. C.	2047	2830	25.7
Beaufort, N. C.	1906	2322	22.0
Delaware River, N. J.	1213	1637	41.6
Eastern Bay, Md.	431	1678	48.6
Seed planted in Chincoteague Bay			
Harris Creek, Md.	4054	8503	5.0
Fishing Bay, Md.	3885	8646	2.8

Duration of the experiment has been too brief to furnish conclusive evidence as to whether or not significant differences in growth exist among the groups of surviving oysters after adjustment has been made to the environmental conditions prevailing at Solomons. That initial differences in growth and mortality are evident has been pointed out. Seed from the local state seed areas and that from Gull Rock, have thus far proven superior for planting under local conditions. However, differences in growth among individuals within a group have been observed to be much greater than those among the group averages. A greater or less number of runts which have made little noticeable growth during the period of measurements has been present in all groups.

The two plantings in Chincoteague Bay shown in Table 3 present an interesting feature in that the Harris Creek seed are native to water which is typically clear and seldom roiled by wave action while the Fishing Bay seed are from a shallow water area frequently roiled by wave action rendering the water rather turbid and silt laden. The latter condition of the water is very pronounced over the soft textured shoals of Chincoteague Bay. Although both groups have made very rapid growth, the ones native to turbid water have done somewhat better in both growth and survival.

These observations in general offer some indication that oysters which have grown for many generations in a given environment may thrive somewhat better in that or a similar environment than will stock transplanted from areas where different conditions prevail. This does not preclude the

assumption that sparsely populated bars where reproduction is slow may have a larger proportion of adult runts or dumpy oysters due to the lack of their elimination through competition. Also, it may be found that certain areas have developed a population which will thrive better when transplanted to a similar habitat than do the oysters native to it. Plantings made this spring have included seed from areas of the Gulf Coast. Future plantings of oysters that have demonstrated rapid growth in their native habitats are plannted.

FISH AND WILDLIFE SERVICE

CLAM INVESTIGATIONS

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The Clam Investigation was authorized by Public Law 556 of the 1948 Congress which was sponsored by the Atlantic States Marine Fisheries Commission and which reads as follows:

("Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,) THAT, the Fish and Wildlife Service of the Department of the Interior is hereby authorized and directed to undertake, in cooperation with appropriate State and interstate agencies, comprehensive studies of the soft-shell clam, *Mya arenaria*, and the hard-shell clam, *Venus mercenaria*, with particular respect to the biology, propagation, and methods of cultivation of such clams. Such Service shall from time to time recommend appropriate measures for (1)arresting depletion in existing productive beds; (2) restoring to production beds formerly productive but now barren or unusable; (3) developing new areas which may be found suitable; (4) improving methods and techniques of digging, transplanting, and handling; and (5) otherwise increasing production and improving the quality of such clams for the benefit of both producers and consumers."

The first step in planning this five year investigation was a survey of the problems in each area along the entire Atlantic Coast. Conferences were held with representatives of the industry, state conservation departments, universities. Particular thanks are due the clam specialists committee of the Atlantic States Marine Fisheries Commission for their valuable guidance in establishing this Program. The results of this survey were used to establish a research program which would attack the most urgent problems in each area to provide the greatest benefit to the industry and to the agencies charged with the responsibility of conservation of this natural resource.

For practical purposes the Investigation has been divided into two parts: (1) Soft-shell Clam Investigation north of Cape Cod; and (2) Hard-Shell Clam Investigation south of Cape Cod. Apologies are hereby made to the Rhode Islanders who like to call their hard-shell clams quahaugs and to the Southerners who like to call their soft-shell clams "long necks" or "mannanoses."

SOFT CLAM INVESTIGATION:

The State of Maine has great quantities of soft-shell clams and an intense commercial fishery. The principal problem of the State of Maine Sea and Shore Fisheries Commission is the management of this fishery so that it shall not become depleted. In places the digging can be greatly increased, in other places it must be curtailed if the industry is to continue.

FISH AND WILDLIFE SERVICE RESEARCH PROGRAM IN MAINE:

Boothbay Harbor has been selected as headquarters for the Clam Investigation as laboratory facilities are available there and also as it is about the center of the soft clam producing area. Three biologists are stationed there at the present time and two bays have been chosen for study to develop methods for management of the clam fishery. These two bays, Sagadahoe Bay and Robinhood Cove, are located at the south and north side, respectively, of Georgetown Island. Sagadahoe Bay is a wide, flat, sandy bay, facing the open ocean. Low tides expose an area of flats three-quarters of a mile long and half a mile wide. From six to twelve diggers work in this area during the Winter and twenty to twenty-five during the Summer. Robinhood Cove which opens at the north side of Georgetown Island is a long, narrow, deep bay with rather steep muddy banks. A relatively small area is exposed at low tide but the shore line is about seven miles long and clams are quite abundant. The same men dig in both Robinhood Cove and Sagadahoe Bay are sell their catch to one or two clam buyers. These buyers have kept daily records of the number of bushels each man has dug for the last three years. They will give us these records and will continue to keep them for us in the future which will enable us to determine catch per unit of effort, or bushels per man tide in both areas.

Each bay will be handled as a separate management problem to determine the amount of clams which can be removed each year without depleting the stock. To determine this we must first learn how fast the clams grow and how many clams are now present in the bay. We must determine how many young clams are added each year by setting and how many die of natural causes, such as predators, silting, freezing, disease, or old age. We have to know how many small clams are killed by the commercial digging and how many eggs are produced by clams of different ages and sizes.

Balancing all of these factors will tell us the amount of clams which can be removed safely each year. This figure

will be compared with the actual production from records kept by the clam buyers. The clam population census will be taken twice each year to check the accuracy of our predictions. We may find, for example, that the diggers are removing fifteen thousand bushels per year when our estimate of sustained yield is ten thousand bushels per year. A decline in the abundance of clams over a period of several years would confirm our predictions that too many clams were being removed.

These studies will also enable us to determine the extent of natural fluctuations in abundance which can then be compared with the changes in abundance caused by digging. These investigations are being conducted jointly by the State of Maine Sea and Shore Fisheries Commission and the Fish and Wildlife Service as pilot plant studies of the management problem. When methods have been perfected the State of Maine will be able to apply these techniques to all of her coast line.

In addition to the management studies at Sagadahoc Bay and Robinhood Cove other problems of mutual interest to the industry, the State, and the Service will be investigated, such as methods of clam farming, cause of "water belly", effect of thinning stunted clams, methods of catching seed clams, best time and methods of transplanting seed, etc.

<u>NEW HAMPSHIRE AND MASSACHUSETTS</u>:

The story of the disappearance of the soft clam in New Hampshire and Massachusetts has received much publicity and is responsible in a large measure for the present investigation. Flats which formerly supported three hundred fifty to four hundred diggers now support thirty-five. Areas which were once productive are now barren. Sewage pollution has closed many of the best areas. The problems in Massachusetts are varied because of the different environmental conditions. Management of the fishery by closed areas and seasons and catch limits seems <u>ineffectual</u> where depletion has become so serious. <u>Farming</u> of soft clams, using methods similar to those developed in Japan, may be a partial answer. <u>Town planting</u> programs may provide enough clams for tourist digging. Perhaps eventually a combination of <u>private farming</u>, <u>town planting</u> for tourist digging, and a <u>managed commercial fishery</u> will solve the problem.

<u>FISH AND WILDLIFE SERVICE MASSACHUSETTS PROJECT</u>:

The Parker River Wildlife Refuge near Newburyport has been chosen for the location of clam research in Massachusetts. Plum Island Sound, resulting from the estuaries of

the Ipswich, Parker and Plum Island Rivers, was once a center of clam production and still has great potentialities. Most of this area is free from pollution and lies within the Refuge where experimental plots are easily protected.

An office has been established at Newburyport and three biologists are stationed there. Arrangements have also been made for cooperative studies with Harvard University in this area.

The Newburyport Unit will establish experimental clam farms and determine their commercial practicability. Spawning and setting of the larvae will be followed to develop methods of obtaining seed clams. Growth rates and mortality of the young clams will be determined. The effects of predators and means for their control will be studied.

In addition, investigations will be made to establish the reasons for the decline in abundance of clams. Past catch records from the town shellfish wardens and the diggers themselves will be obtained to determine if overdigging can account for the decrease or if it could be a periodic fluctuation as some believe. Observations of areas closed because of sewage pollution should yield some valuable information concerning changes in abundance where there is no commercial fishery. The Joppa Flats, at the mouth of the Merrimack River, are full of large clams but have no small ones. This may indicate that no setting has occurred during the last three years or that some unfavorable condition has killed the smaller clams. Spawning and setting will be studied here during this Summer to determine if reproduction is normal.

All of this work will be in close cooperation with the Woods Hole Oceanographic Institution project at Barnstable and the Shellfish Program of the Marine Fisheries Division of the Massachusetts Department of Conservation.

HARD CLAM INVESTIGATIONS:

The great range of *Venus mercenaria* from New England to Florida and the variety of conditions under which it exists makes the selection of sites for research very difficult. Eleven states are involved and each would like to have a project located within its borders. The limited appropriation makes it necessary to concentrate the work in a few representative areas where the most valuable results can be obtained. Cooperative studies with State Conservation Departments and universities are planned to utilize existing research facilities as much as possible.

NEW JERSEY:

The extensive hard clam fishery of New Jersey, plus the research project of Dr. Thurlow Nelson and his group at Rutgers University, present many opportunities for joint studies. A cooperative agreement has been established between Rutgers University and the Fish and Wildlife Service to facilitate research on quahaugs in this State. During the Summer of 1949 two graduate students will be assigned to work with Dr. Nelson's group on certain phases of the problem. (1) One man will try to develop methods of obtaining seed clams from natural reproduction. We know that clean shells placed in the water at the proper time will catch oyster spat, but how can we catch clam spat? Until methods of obtaining seed clams are developed commercial clam farming can never be feasible. In Japan loosely woven palm fiber matting is hung in the water and the ark-shell clams attach as heavily as fifteen hundred per square foot. Maybe similar methods will be successful here with the hard shell clam. Perhaps changing the character of the bottom in certain places like the Woods Hole Oceanographic Institution is doing at Barnstable will induce setting of quahaugs also. It may be possible to locate areas where natural setting is very heavy and where seed clams can be strained from the sand. These are the possibilities that one of the biologists at Rutgers will explore this Summer.

(2) The other graduate student working with Dr. Nelson's group will investigate the basic problem of identifying the organisms used as food by hard clams in New Jersey waters. This information is necessary for a complete understanding of the growth rates in different areas.

VIRGINIA:

A preliminary survey of the clam fisheries of Virginia has been made and conferences have been held with the biologists of the State Fisheries Laboratory. Cooperative

studies are planned for the future and it is expected that the results of clam farming experiments can be adapted for use along the Eastern Shore.

NORTH CAROLINA:

A preliminary survey of the clam fisheries of North Carolina was made during February. Plans have been made to base Southern Clam Research at the Beaufort Laboratory of the Fish and Wildlife Service. A fairly good clam industry is located in the vicinity of Beaufort and a great variety of environment conditions are to be found.

Fundamental studies of the rate of growth, age at maturity, and salinity tolerance, as well as development of practical methods for increasing and managing the fishery will be conducted here. It may be possible to develop methods of commercial clam farming near Beaufort which will be applicable to the southern part of the Atlantic Coast.

SOUTH CAROLINA:

The problem of developing the fishery is important in South Carolina as in North Carolina. Clams are present in some abundance along most of the coastline, but the fishery is limited by economic factors.

The development of hard clam farming may offer an opportunity for increasing production at some future date, but the demand must increase before farming can become profitable.

FLORIDA:

A survey of the clam fisheries of Florida was made during February with interviews of representatives of the industry and research agencies. The present fishery is very limited although great quantities of clams were once taken by dredge in the Ten Thousand Islands. The cannery at Naples is now closed and the dredge has sunk. The beds among the islands still contain many clams and it is important to know the true extent of this resource for proper management and development of the fishery.

CONNECTICUT:

The quahaug fishery of Connecticut is small but might be expanded by farming in connection with the oyster industry in Long Island Sound.

No field work is anticipated here at present but funds have been allocated to Dr. Loosanoff at the Fish and Wildlife Service Shellfish Laboratory at Milford to develop methods of artificial propagation. This work will explore the possibility of producing seed clams in hatcheries while the field units in Rhode Island and New Jersey investigate seed production from natural spawning and setting.

RHODE ISLAND:

An intensive quahaug fishery by tonging, raking and power dredging methods is located in Rhode Island. Tonging is conducted the year around in every clean part of Narragansett Bay by about thirteen hundred diggers. Power dredging is permitted only in part of the Sakonnet River from December 1st to March 31st and supports less than thirty-five boats. A serious controversy has developed over the relative merits of these two methods and the Fish and Wildlife Service has been asked by the industry and the State Conservation Department to settle it. Tongers claim that power dredges tear up the bottom killing the seed and breaking many of the marketable sized clams. Dredgers claim their operations cultivate the bottom preventing silting and increasing setting. Dredgers want additional beds which are too deep for hand tongers opened for the use of power dredges.

Two biologists are now stationed at Wickford, R. I., and have just completed a survey of the hard clam population throughout the Bay in cooperation with the Narragansett Marine Laboratory of the Rhode Island State College. This information will be used to select a representative area for experiments to test the effect of hand vs. power methods on adult clams, juvenile clams, setting, and related bottom forms such as fish and scallops.

Part of the test area will be hand tonged or raked and another part will be dredged. Equal amounts of hard clams will be removed from each plot. Periodic examinations will show the effect of each method.

The results of this experiment will find application all along the coast wherever controversies exist between hand and power methods of clam fishing.

Seed production from natural spawning will be investigated this Summer by the Rhode Island unit as a beginning of quahaug farming studies. Although clam farming is not permitted in Rhode Island at present, the methods developed here should apply in other places.

A management study area is also planned for Narragansett Bay. One part of the bay which supports a small fishery will be observed and records will be kept of actual catch. Methods similar to those described for the soft clam studies in Sagadahoc Bay and Robinhood Cove in Maine will be used to arrive at an estimate of the sustained yield. This estimate will then be compared with actual production and correlated with quahaug population trends in the bay.

Management methods developed here can be applied wherever a State Conservation agency has the responsibility of regulating the fishery.

I would like to close with this thought. The program of the Clam Investigations is flexible and can be shaped to fit the needs of each area. We would welcome suggestions of the industry to help us establish studies which will provide the most benefit to all concerned.

THE SPAWNING OF QUAHAUGS IN WINTER
AND CULTURE OF THEIR LARVAE IN THE LABORATORY

-by-
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The success of any shellfishery, including that of the hard shell clam, Venus mercenaria, depends to a large degree upon the availability of a supply of young individuals, commonly called set or seed, which can later be grown to marketable size. In some areas sets of young clams are heavy enough to take care of local needs; in others, which unfortunately are more common, the sets are usually irregular and light. Realizing the importance of having a good supply of seed Belding (1912) tried to raise young hard shell clams by artifical means under laboratory conditions. Unfortunately, Belding was not successful, because most of the larvae in his cultures died either before they reached the straight hinge veliger stage or soon afterwards. Belding concluded that there was no practical method for raising hard shell clams to the setting stage because of the small size and delicate nature of the eggs. Nevertheless, several years later Wells (1927) showed that by using a certain technique clams could be propagated artificially from the egg to the setting stage. Wells, however, was mostly interested in oysters and did not continue the clam work.

Our entrance into the field of raising clam larvae was motivated by several considerations. First, we still believe that by developing proper and efficient methods artificial production of clam seed may be economically feasible. Secondly, if we could succeed in keeping clam larvae of different ages in the laboratory, a wide field would be opened for studies of the physiological requirements of larvae, and also for studies of the effects of different factors of environment on larval growth and survival. Such information should be extremely important for understanding why some areas produce heavy clam sets while others fail. Finally, the methods developed for raising larvae to the setting stage will offer us the opportunity to enter the field of selective breeding by crossing the individuals with certain desirable characters, such as unusually rapid growth, etc. The latter may appear somewhat far-fetched at this time but we believe, nevertheless, that selective breeding of commercial mollusks will become a reality within a few decades.

Working with the hard shell clam is not new to Milford Laboratory because one of us has been studying intermittently various aspects of the

clam's biology for the last 16 years. Our first extensive experiments on raising clam larvae were, however, undertaken some time last summer. Clams were stimulated to spawn under laboratory conditions and several cultures of larvae were grown to the setting stage.

Obtaining spawn in the summer time is relatively a simple procedure. During the summers of 1933, 1934 and 1935 many clams were induced to spawn simply by raising the water temperature a few degrees (Loosanoff, 1937). However, because the spawning season of clams in our waters is confined to a period of approximately 2 or 3 months, experimenting with their eggs and larvae were necessarily also confined to the same period of time. Fortunately, since a method has been recently devised to induce oysters to develop spawn in the winter time (Loosanoff, 1945), we decided to apply this method to clams also, hoping in this way to extend considerably the period during which ripe eggs and sperm could become available for laboratory work. The method was successful, and by using it we are now able to make clams spawn, thus obtaining their eggs and spermatozoa, throughout the winter and spring. The method was successfully tried by other groups of investigators to whom we described it.

It should be remembered that under natural conditions there is a marked difference in the condition of the gonads of oysters and clams during the winter time. As has been shown (Loosanoff, 1942), the oysters of our waters resorb remnants of their gonads after spawning, pass through a stage when the follicles are free of all but the indifferent cells, and then, just prior to hibernation, enter a brief period of gametogenic activities during which ovogonia and young ovocytes are formed in females, while in males a few spermatocytes may be found in some follicles. In general, however, the gonad remains undeveloped consisting of a few follicles scattered in the form of small islands throughout the connective tissue which lies in the area between the body wall and the digestive gland. In this stage the oysters enter into a long period of hibernation, which in our waters lasts approximately from the end of November until April.

In hard clams, on the other hand, an active and very rapid gametogenesis begins soon after the completion of spawning, and by the end of October active spermatozoa can be found in virtually all the follicles of the males (Loosanoff, 1937a). Thus, excluding a brief post-spawning

period the gonads of adult males of *Venus mercenaria* contain spermatozoa that appear to be morphologically mature at all seasons of the year.

In the females the proliferation of follicles and growth of young ovocytes is also very rapid during the latter part of October. Towards the end of November and in December the ovaries already contain mostly large ovocytes of mature appearance. Thus, the gonads of female clams collected late in the fall or in the early winter appear morphologically ripe. Therefore, if we compare the gonads of clams and oysters in the late fall or in the winter, we shall find a striking difference between them because while in oysters they are in typical winter condition, containing only a few immature sex cells, clams already have either fully developed sperm or large ova. It is possible that this difference explains somewhat the better viability of eggs and larvae of winter-conditioned clams, as compared with those obtained from oysters conditioned in the same way.

Our method for conditioning clams to spawn in the winter time can be briefly described as follows: Clams brought from their natural beds in Long Island Sound, where the temperature of the water in the winter time is near 0.0°C., are placed in trays of running sea water having a temperature of approximately 5.0 to 7.0°C. Then, at intervals of 3 to 5 days the temperature in the trays is increased by several degrees. Eventually the temperature is raised to about 22.0°C., and the clams soon become ready for spawning. The entire conditioning period usually takes about 3 weeks, but can be made even shorter if the intervals between the increases in temperature are shortened to about one day, or if the clams are placed directly into water of a temperature of about 20.0°C. Under the latter condition we were able to make clams spawn on the eighth day of the conditioning period.

Conditioned clams are induced to spawn by raising the temperature of water to about 32.0 or 34.0°C. If the temperature is raised above 34.0°C., most of the clams usually withdraw the siphons and close the shells. It was often noticed that spawning begins during a decrease in temperature, i.e., if the temperature is first raised to about 35.0°C., and then gradually decreased to 32.0 or sometimes even to 28.0°C.

In several instances cases of spontaneous and apparently unprovoked spawning were observed at temperatures several degrees lower than 24.0°C., which had been considered the minimum at which

clams could spawn. For example, on February 7 and March 4, 1949 clams were seen spawning at 22.0°C., and on March 28 and April 5 large groups spawned in the trays having a temperature of only 21.0 and 20.6°C., respectively. In all cases both males and females were spawning, many of them quite profusely. The eggs from these spawnings were collected and cultured, the larvae reaching the setting stage. In the first two cases the clams had been used earlier in the day in spawning experiments during which they were subjected to a temperature of about 34.0°C.; however, after that they had been moved back to the tray of running water at 21.0 to 22.0°C., and remained there for about six hours before beginning to spawn. The third group, however, had not been exposed to a temperature higher than 22.0°C. for at least 11 days prior to the spontaneous spawning, and the last group, which spawned on April 5 at 20.6°C., was just transferred there several hours before from the conditioning tray of 15.0°C. Regardless of the nature of the factors that caused the spawning it is important that it took place at such comparatively low temperatures, thus suggesting that in nature clams can also spawn under the same condition.

While conducting the spawning experiments it was established that spawning of an individual clam is not completed in one day but is spread throughout a long period. For example, in one of our groups a marked female was induced to spawn on six different occasions between February 2 and March 3. Many other animals of the same group spawned several times. In general, this group provided us with spawn for a period of approximately 5 or 6 weeks, before the majority of the clams became spent.

Contrary to observations on oysters, spawning of which can be induced by the addition of a suspension of sperm or eggs, clams do not react sharply to this type of stimulation. The majority of ripe clams could not be induced to spawn by the addition of a suspension of sex products. However, many would respond if the temperature was raised several degrees. Apparently temperature was a more important factor than chemical stimulation.

Not all the eggs discharged in our experiments by the spawning females possessed the same vitality. Probably some clams were compelled by the strong temperature stimulation to abort the eggs even if the eggs were not fully ripe. Such eggs usually developed into feeble larvae which soon died. The last batches

of eggs discharged by virtually spent females also gave feeble larvae that grew slowly and showed a high mortality. With a little experience, however, an investigator can learn to recognize various types of spawnings and select only those batches of eggs that are suitable for cultivation. We found it rather difficult to induce spawning of clams, which were about 4 inches or more in size. Smaller clams, measuring about 3 inches, usually responded better than the larger individuals.

The eggs used for cultivation of the larvae were fertilized as soon as they were discharged. To separate them from the debris accumulating in the spawning dishes the eggs were run through a stainless steel sieve, which allowed the eggs to pass through but retained the larger particles. After that the egg suspension was filtered once more through another sieve, which was fine enough to retain the eggs but let the water containing the sperm, blood cells, etc., pass through. The retained eggs, now free of all impurities, were placed in fresh sea water in the hatching jars, which were continuously aerated.

The eggs and later young larvae remained undisturbed until they developed into early veliger. Then the water in the jars was renewed about every second day. To accomplish this the content of the jars was strained through fine sieves, which retained the larvae but let the water pass through. The jars were then filled with new water and the larvae returned to them.

To feed the larvae small quantities of mixed plankton cultures, consisting primarily of forms of about 5μ in size, were added daily to each jar. When the larvae were reaching the setting stage old oyster shells were placed on the bottom of the jars to provide a place for attachment, or the larvae were transferred to special aquaria on the bottom of which a layer of sand was spread.

A description of the development of the egg and clam larvae has already been given by Belding (1921). Therefore, it is not necessary here to go into most of the details. Instead we shall offer a comparatively brief account of the development from fertilized eggs to the dissoconch stage, as observed in our laboratory on good batches of eggs kept at about 22.0°C.

The egg of the clam measures about 70μ in diameter (Figure 1,A). It differs from the eggs of many other lamellibranchs because it is surrounded by a thick gelatinous envelope the diameter of which varies from approximately 163 to 170μ. We noticed on many occasions that this membrane continues to surround the egg past the blastula stage and, sometimes, until trochophore larvae are formed. If at fertilization spermatozoa are numerous, many can be seen imbedded in the outer portion of this envelope.

The fertilized egg will reach the two-called stage in about 45 minutes (Figure 1,B), and the four-celled stage is reached in about an hour and a half (Figure 1,C). In about 6 hours the embryo becomes a well developed, rotating, ciliated blastula. The early gastrula stage is reached 9 hours, and finally the larva enters into the trochophore stage which is reached about 12 hours after fertilization (Figure 1,D). This form, roughly pear-shaped, moves through the water with a spiral motion, propelling itself by a circlet of cilia around the anterior end, aided by a velar tuft of longer cilia at the extreme anterior. In this respect it differs from the gastrula stage during which almost the entire body of the larva was covered with small cilia. Furthermore, the trochophore larva begins to form a primitive mouth and develops a shell gland. The larva at this time measures about 90 x 65μ.

As the development progresses, a small thin shell is secreted by the shell gland and is gradually extended to cover the entire animal. This usually occurs from 24 to 36 hours after fertilization and the larva is now in the early veliger or early straight hinge stage (Figure 1, E). Its size at this time is approximately 105 x 80μ. About 8 to 12 hours later a true veliger or straight hinge stage is attained. (Figure 1, F). At this stage the larva, which is approximately 110 x 90μ in size, becomes quite a proficient swimmer using for this purpose its highly developed velum.

If conditions are favorable, the veliger continues to grow reaching the size of about 122 x 98 by the end of the fourth day, but still remaining in a stright hinge stage (Figure 1, G). By the sixth day it is already in the early umbo stage and measures approximately 154 x 143 (Figure 1,H). In 8 days some rapidly growing larvae may reach the size of 205μ, while the average are in the medium umbo stage measuring 195 x 178μ (Figure 1,I). After about 10 days after fertilization many individuals in good cultures are in the late umbo stage, measuring about 214 x 192μ (Figure 1,J) and after 12 days some of the mature, ready-to-set larvae may be as large as 227 x 210μ (Figure 1,K).

Just prior to this stage clam larvae begin to undergo very prominent changes. The velum begins to disappear and some of its functions are taken over by a foot which is covered with numerous cilia. At first this ciliated foot aids in swimming, but gradually is used more in gliding over the bottom and in crawling. Eventually the velum entirely disappears, thus ending the free-swimming period.

In our cultures many larvae reached the setting stage in about 12 days attaining at that time the size of about 210μ. Young clams of this size were often seen attached by the byssus to the shells which were placed on the bottom of the aquaria. Thorson (1946) states that the veligers of Venus gallina also very often set when they are only about 210μ, although the length of the prodissoconch varies between 210 and 225μ. We found even greater variations in the size of the prodissoconch shell of Venus mercenaria grown in our cultures, some of them being as large as 240μ. However, none of the prodissoconch of our cultures ever approached the size of 320μ as reported by Sullivan (1948) for the Venus Larvae of Malpeque Bay. Nevertheless, as Jorgensen (1946) showed, the size of the larvae at the time of setting may vary considerably according to the conditions of the environment and, therefore, the measurements made at setting are only of relative importance.

After the attachment the young clam begins to form the adult or dissoconch shell. Successive stages of growth showing the increase in size and formation of adult shell are given in Figure 1, L, M, N, O and P. The sizes of these small clams were 240 x 223, 260 x 245, 313 x 308, 366 x 340 and 463 x 423μ respectively. The oldest individual shown was 28 days counting from the day of fertilization. In general, under laboratory conditions the growth of recently set clams was rather slow.

Significant variations in the sizes of the individual larvae of the same cultures were very often noticed. For example, while some of the largest larvae were approximately 210μ in size and were ready to metamorphose, the other larvae of the same culture were only 150 or 160μ long and were still far from the end of the free-swimming stage. Sometimes, because of overcrowding, a difference in temperature or other factors, the average size of the larvae of two parallel cultures carried in two different jars would also show significant differences.

Occasionally, almost all individuals of some cultures would appear to be abnormal. These abnormalities were usually caused by unfavorable conditions, such as low temperature, lack of food, etc. Sometimes, if these conditions were corrected

while the larvae were still in the early stages, some of them would survive and eventually develop into normal individuals which would reach the setting stage.

We found that the method for staining oyster larvae, which we described some time ago (Loosanoff and Davis, 1947) is also applicable to clam larvae. By using a weak solution of Neutral Red clam larvae were stained and thus became easily distinguishable from the normal individuals. It is believed that this method will help, later on, to study the dispersal of larvae from the place of origin, their rate of growth under natural conditions, etc.

Our experiments showed that clam larvae are not too selective in their food and will survive and grow on different diets composed of different micro-organisms, instead of being confined to a few forms, as the larvae of O. virginica seem to be. The execption was when the clam larvae were fed almost a pure culture of Chlorella. The larvae so fed grew more slowly and showed a heavier mortality than these which were fed mixed plankton cultures containing different green algae, flagellates, bacteria, etc.

In conclusion it may be said that our experiments showed rather conclusively that cultivation of clam larvae to the setting stage is comparatively an easy matter. By following the few simple principles and rules given in this article mature sperm and eggs can now be obtained on almost a year-round basis, and the resulting larvae can be grown to the setting stage even in the middle of winter. In other words, as far as research work is concerned, we can now accomplish in one year as much as could previously be accomplished in three or four. With the method well developed and with the possibility of using it in summer and winter we are now looking forward to carrying on a number of experiments devised to study the ecological and physiological requirements of clam larvae, and to begin preliminary work on selective breeding of clams.

S U M M A R Y

The method is described by means of which hard shell clams (V. mercenaria) can be made to form ripe gonads and to spawn under laboratory conditions in winter. The method of raising clam larvae to the setting stage is also described in detail.

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Growth Studies on the Quahaug, Venus mercenaria

Harold H. Haskin, Rutgers University
The State Universiyt of New Jersey.

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Two years ago commercial funds were made available to us through Rutgers University to examine the problem of hard clam farming. Specifically it was desired to know whether or not it would be practical to establish hard clam farms on the same stable basis of culture employed in the oyster industry. As you undoubtedly know, the hard clam industry at present is based on the exploitation of a wild crop and is consequently characterized by great fluctuations in yields, prices, etc.

Our thinking in attacking this problem was guided by the experience of Dr. Thurlow Nelson along the lines indicated by many of the papers on oyster problems discussed at these meetings. Obviously to establish hard clam culture, it is necessary to insure a supply of seed and secondly to be able to raise it to marketable size without excessive mortalities. I will not discuss our efforts to secure seed clams - we have had some success in artificial spawnings and some slight success in trapping natural spawn, but we are looking to the techniques of the Milford Laboratory, as described here by Dr. Loosanoff and Mr. Davis, to supply us with seed. I will consider briefly here some aspects of the second group of problems i.e., the raising of seed clams to marketable size. In simplest terms the problem is "How long does it take to raise a marketable clam?"

When one thinks of measuring a growth rate, the first question that arises is, "What dimensions are best used?" In our first year of work we made measurements of length, height, thickness, volume and weight of clams of all sizes available.

The <u>first slide</u> indicates the results of measurements of over 2000 clams with length, height, thickness and weight measurements averaged for groups of ten. It is seen here that when height, width or the cube root of the weight is plotted against length, a straight line is obtained. This shows that there is no change in proportions of these clams as they grow larger. These data plots are particularly useful in that if one average dimension for a group of clams is known the other dimensions may be obtained directly from the graph. For example one can weigh a group of 10 clams and immediately read off the average length, width and thickness of the group with an error of less than 5%. Because of the relative ease of obtaining weights as contrasted with caliper measurements, weights are now used in most of our growth studies.

One way of studying growth rates of clams is to make experimental plantings of all sizes available, measure the increase for each size for a single growing season and then add all these increases together to get a composite curve covering the growth of the clam from seed to chowder size. This is essentially what we have done.

The second slide shows the growth curves for five different sizes of clams for the 1947 growing season on the tide flats of Delaware Bay, Pierces Laboratory, Cape May County, New Jersey. The sizes planted here ranged from 10,000 per bushel to less than 200 per bushel. Note that the smallest clams showed the greatest percentage gain in weight - about 570% - while the largest clams gained only about 7% in the season.

The third slide shows these percent-gain data plotted to show a relative growth curve for the hard clam for the conditions obtaining at the Cape May location in 1947. This curve enables us to compute yields and sizes of clams obtainable from seed of any given size, assuming that a succession of similar growing seasons will occur. For example, 1 bushel of seed clams weighing about 1/3 of an ounce apiece, would yield 18 bushels of medium-sized clams in 5 such growing seasons. This checks almost exactly with growth rates obtained by Dr. Belding at Wellfleet, Massachusetts in 1906-1909.

This slide shows also the relative growth curves for this area in 1948 and for 4 other areas in 1948. Note that in none of these cases do the growth rates equal the first figures obtained in 1947.

The fourth slide shows these growth data plotted in the form of the more conventional cumulative growth curves. These show for example that 1 oz. seed clams planted under the conditions existing in the Cape May area in 1947 would grow to chowder size in an additional three to five years. Under the conditions existing here in 1948 about 7 years would be required. Growth curves are also shown for the Jarvis Sound, Edge Cove, Surf City and Raritan Bay areas.

The fifth slide represents an attempt to gain further information from these growth data. Here for each area the logarithm of the initial weight at the beginning of a growing season, is plotted against the logarithm of the ratio of the final weight to the initial weight. A series of parallel straight lines results, with each line representing a certain planting area. The approximate formula for

these lines is

$$F = I^{2/3} \times \text{Constant}$$

where F = final weight at end of growing season

I = initial weight at beginning of growing season.

The constant depends on the intercept of the line.

The exponent of I (approximately 2/3) depends on the slope of the lines.

Since a two-thirds power of a weight is an expression of surface area, this empirical relationship between initial weight and final weight at the end of the growing season suggests that some exchange between the clam and its environment, limited by the surface area of the clam, is controlling the season's growth. With increasing size of the clam the ratio between its surface area and volume becomes more unfavorable and this is accompanied by a slower growth rate.

The intercepts of these straight lines with the zero axis of log $\frac{F}{I}$ enable us to calculate a theoretical limiting size for each of the areas investigated. This limit indicates a size beyond which the clams would grow only in more favorable growing years. For the Cape May area in 1947 the limit is 250 grams, for the Surf City area in 1948 it is 150 grams and for the Raritan Bay area in 1948 it is 64 grams.

It is interesting to consider what will happen to clams transplanted into an area which has a limiting value less than the size of the transplanted clams. This was actually done in the Raritan Bay area in 1948. Five sizes of clams were planted in the area in the spring. All were of uniformly high meat quality (approximately 18% wet weight). The three smaller sizes, all below the theoretical limit of 64 grams for the area, held their high meat quality. The two larger sizes, clams "too big for their new environment," declined sharply in meat quality to about two-thirds the initial meat level.

This study of hard clam growth is being continued in various New Jersey waters. To date it has shown several things which promise to be of considerable value to the prospective "clam farmer".

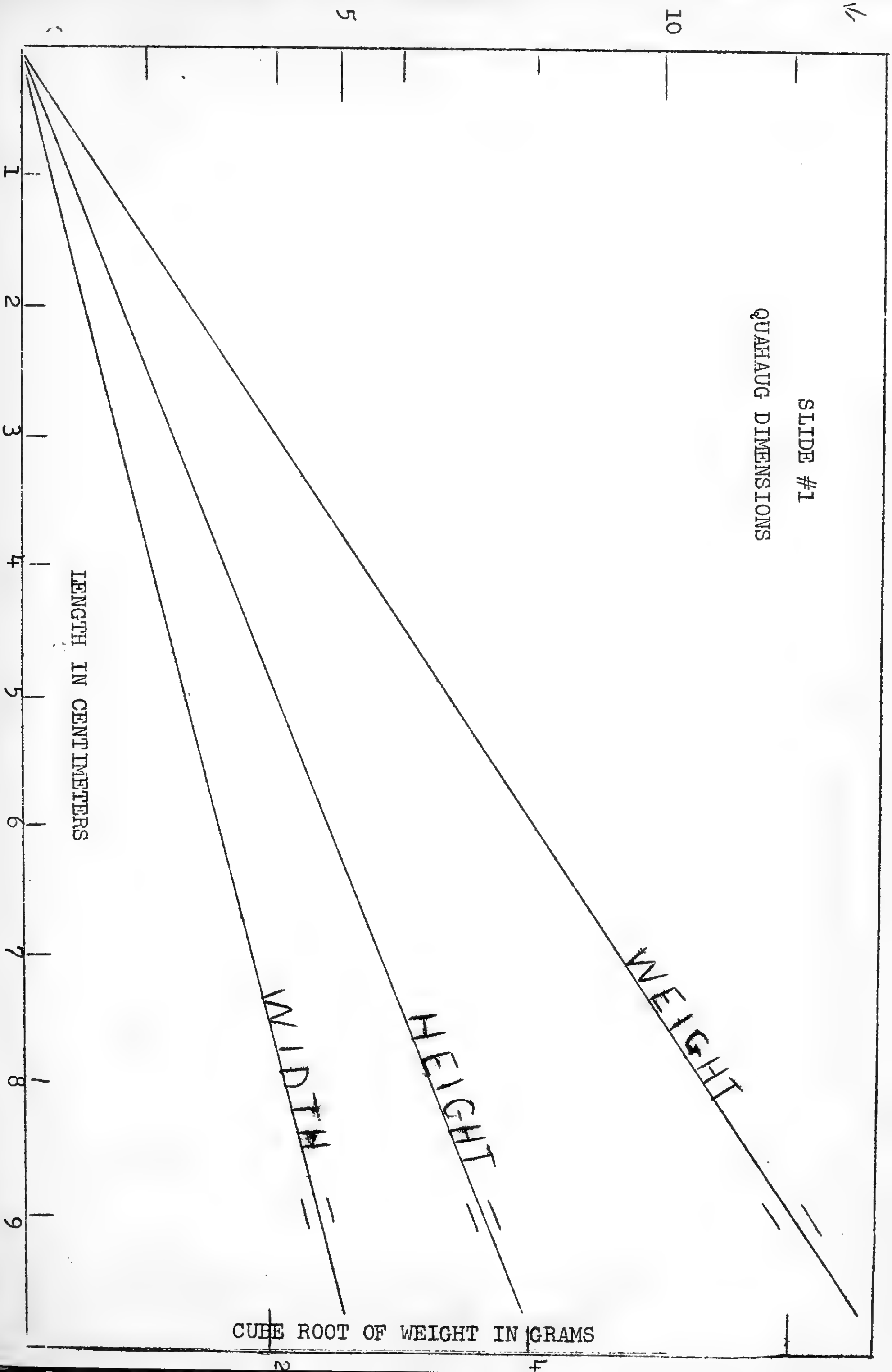
1. The approximate times required to raise seed clams to market sizes.

2. The great differences in growth rates for the same year in different locations and from year to year in the same location.

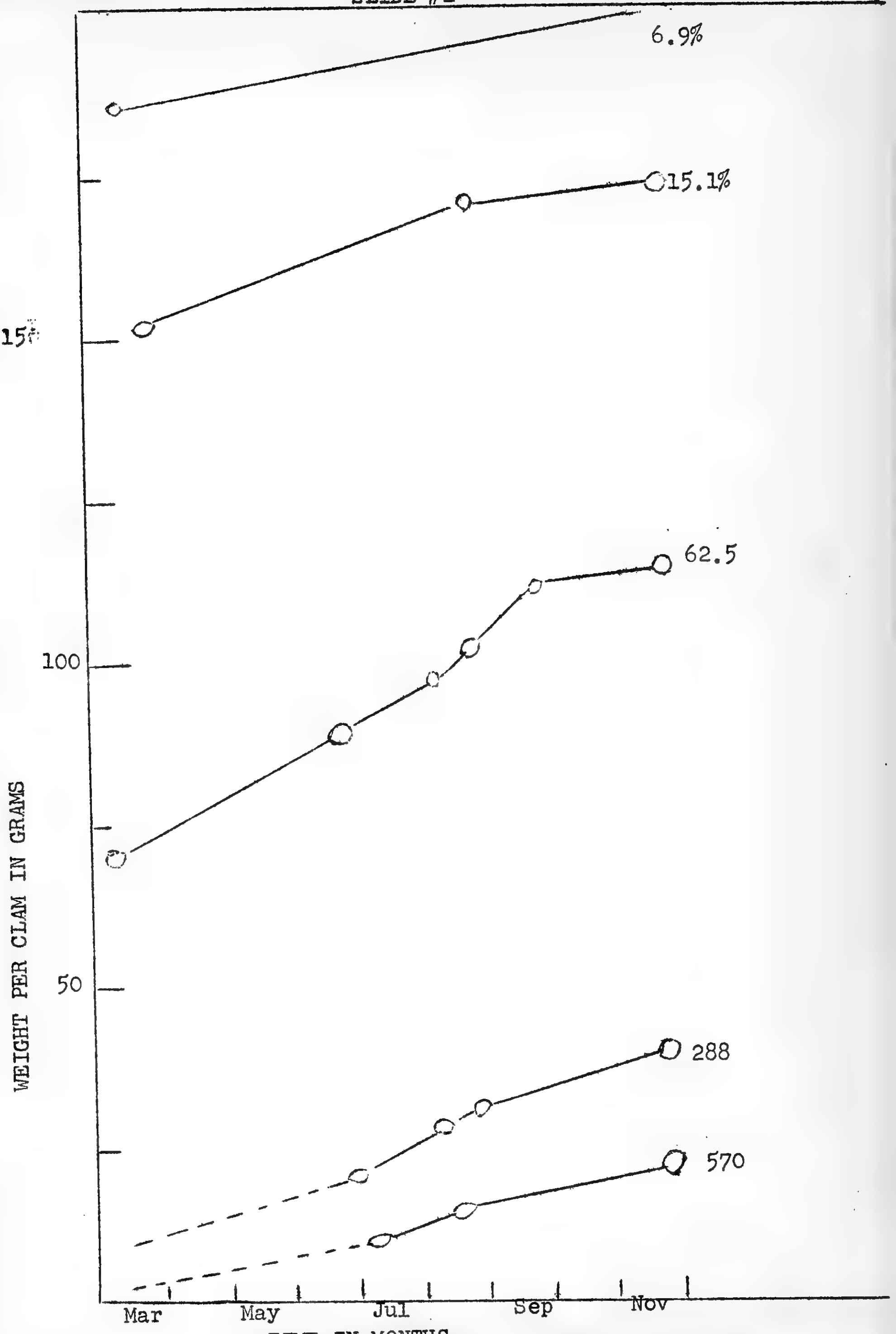
3. That the growth in any one season is limited by a surface area to weight relationship which indicates control of growth by environmental exchanges.

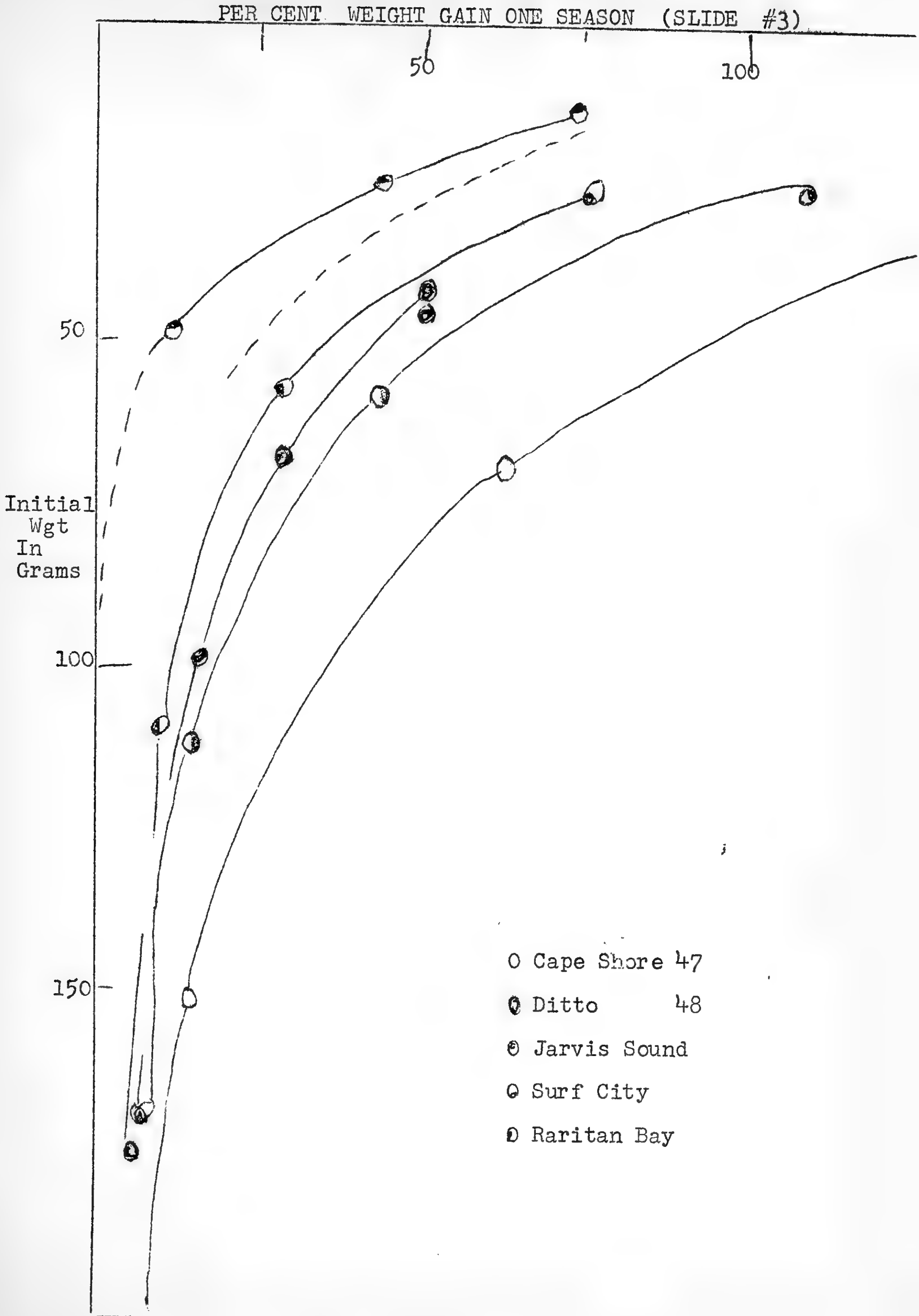
4. The size limit for a given area will indicate whether the clam-farmer should attempt to grow "cherry-stones", or "chowders" or neither in that area.

5. A low theoretical size limit for a given area indicates that it is unsuitable for "laying-out" larger clams for any considerable period of time.

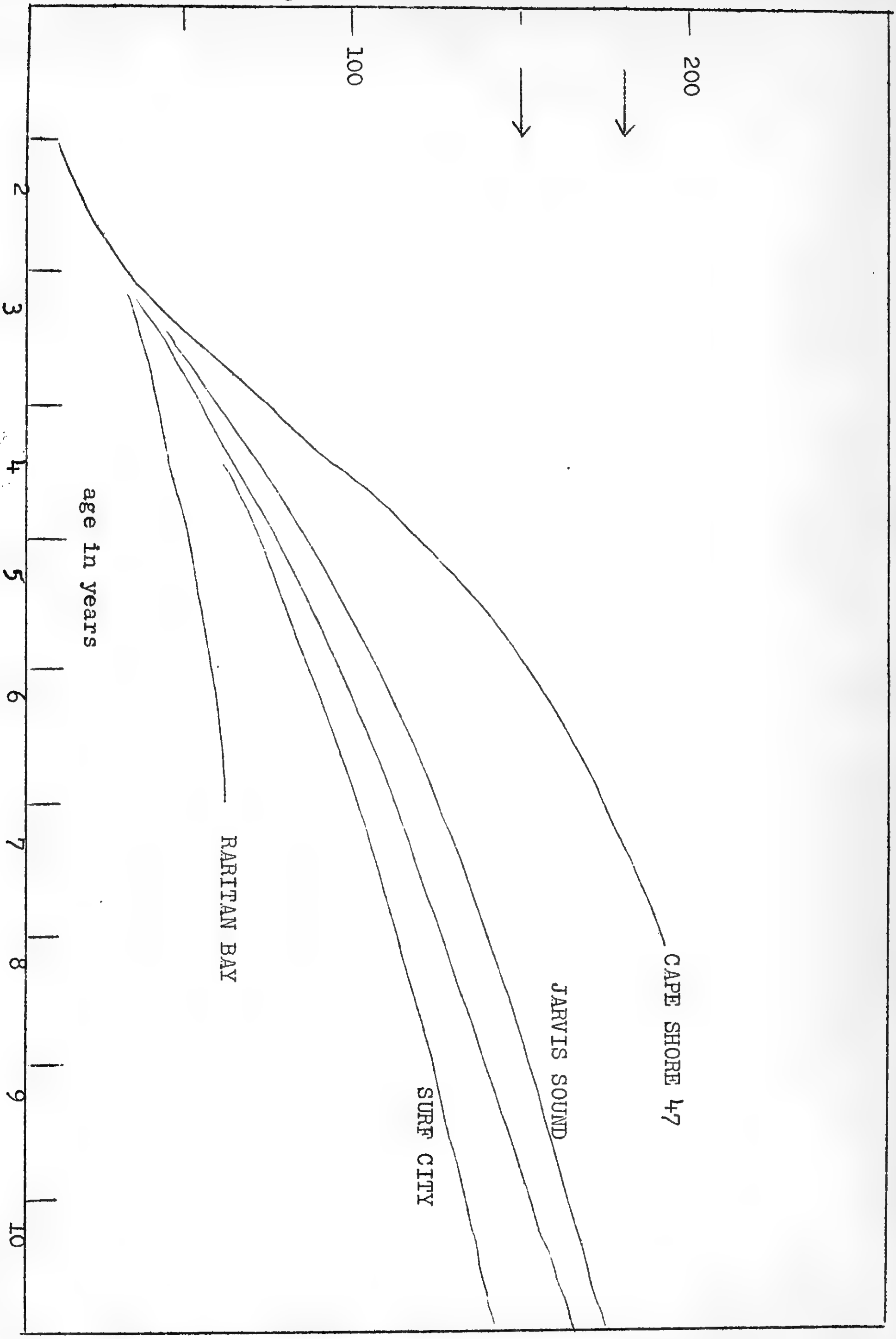

HEIGHT - WIDTH IN CENTIMETERS
5
10
SLIDE #1
QUAHAUG DIMENSIONS
LENGTH IN CENTIMETERS
1
2
3
4
5
6
7
8
9
WEIGHT
HEIGHT
WIDTH
CUBE ROOT OF WEIGHT IN GRAMS
2
4

SLIDE #2

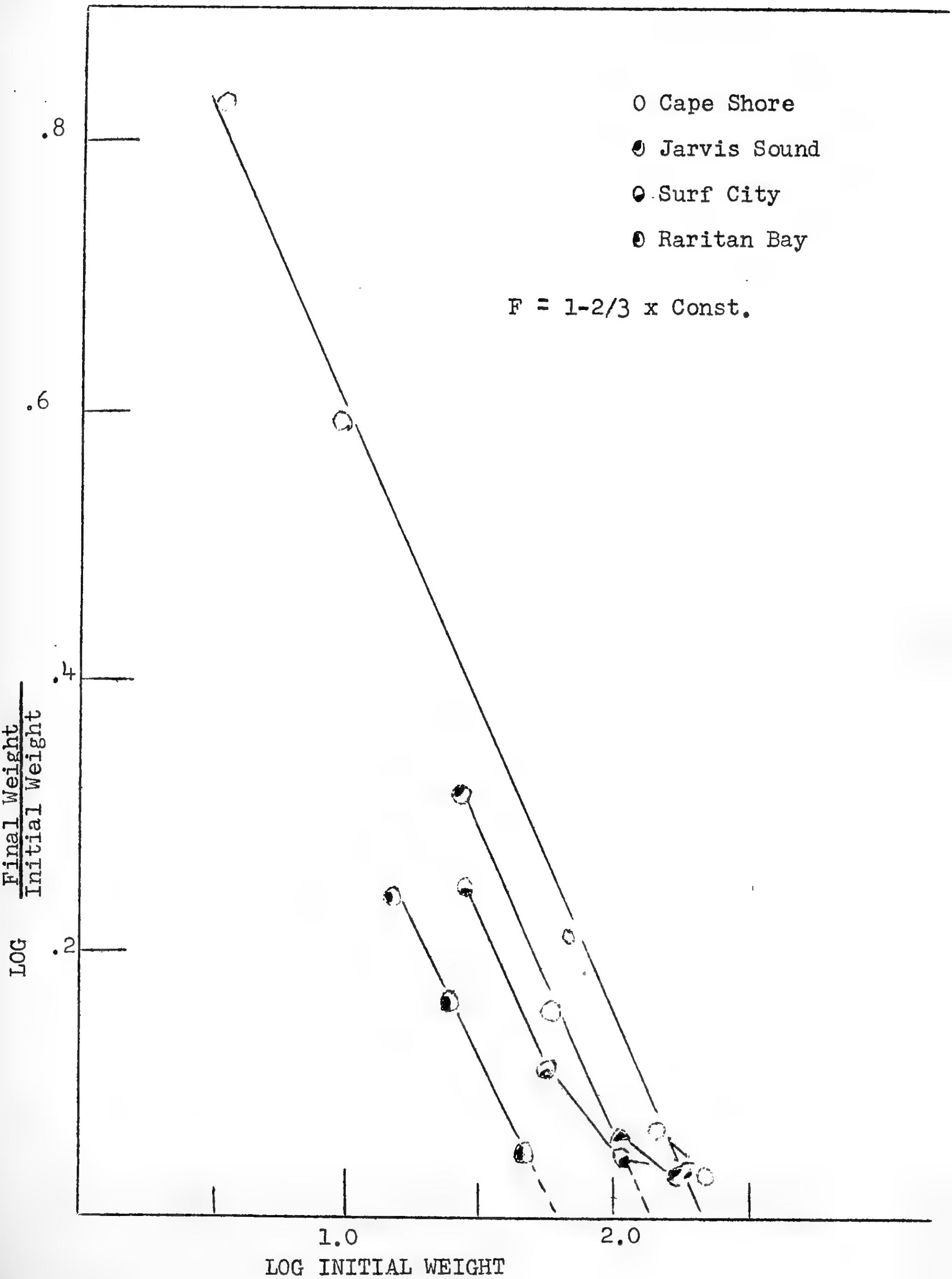

6.9%
15.1%
62.5
288
570
150
100
50
WEIGHT PER CLAM IN GRAMS
Mar
May
Jul
Sep
Nov
TIME IN MONTHS


PER CENT WEIGHT GAIN ONE SEASON (SLIDE #3)
50
100
Initial Wgt In Grams
50
100
150
O Cape Shore 47
Ditto 48
Jarvis Sound
Surf City
Raritan Bay

Weight in Grams (Slide #4)



SLIDE #5


O Cape Shore
Jarvis Sound
Surf City
Raritan Bay
F = 1-2/3 x Const.
.8
.6
.4
.2
LOG $\frac{\text{Final Weight}}{\text{Initial Weight}}$
1.0
2.0
LOG INITIAL WEIGHT

Practical Problems of the Propagation of the Soft Shell Clam, *Mya arenaria*

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The needs of the clam farmer are essentially the same as those of the oyster grower. He must have some sort of title to control a suitable plot of ground. He must also have some means of seeding or populating that ground with stocks of clams. Finally he must have some idea as to what to expect in the way of losses from predators, natural mortality, and destruction caused by other agencies.

In New England, clam farming has never been developed to the same extent as has oyster growing. It would appear that tradition and nature have conspired against the clam farmer to prevent him from attaining his primary needs. The traditional idea of free fishing in the intertidal zone has made it very difficult for private individuals to secure control of suitable ground. In addition, factors which control setting are unknown to that once ground is secured, the clam farmer has no way of getting his plot seeded. Finally, the effects of numerous enemies are difficult to evaluate since they operate below the surface of the sand.

In 1947, several residents of the town of Barnstable, Massachusetts obtained leases on a barren flat in Barnstable Harbor and requested the Woods Hole Oceanographic Institution to conduct a series of investigations on propagation and growing of soft shell clams. A seven-acre plot, adjacent to the leases, was set aside for experimental purposes.

Two methods of populating barren areas appeared promising. The first involved transplantation of contaminated stocks which could be obtained from polluted areas at a reduced price. It was found that transplantation could be satisfactorily effected by simply broadcasting the clams on untreated flats, and the majority of the clams would dig in and establish themselves quickly. It did not appear necessary to plow or otherwise treat the surface before transplanting.

The second method involved treatment of the surface to induce setting. There were a few records of intense sets which occurred on new flats created as a result of dredging operations. There was also a former clam grower who claimed to have induced setting by resurfacing his flat with sediments taken from a special thatch island. Several test plots

were resurfaced with a variety of materials and it was found that setting occurred on most of them. The most satisfactory soils were composed of very fine sediments which also contained roots and other fibrous material. Certain soils would induce setting but lacked physical properties to withstand winter storms and ice. It has not been determined as yet how these new sediments induce setting, but the matter is under investigation.

The problem of predators turned out to be much more serious than had been expected. It was know that certain crabs, crab-like organisms, and boring snails subsisted on soft clams but there was very little information as to how much damage these organisms actually did. During the spring of 1948, severe losses occurred in the stocks which had been experimentally transplanted and careful observations indicated that the common horseshoe crab was the responsible predator. Laboratory tests confirmed the field observations. It was finally determined that a large horseshoe crab could probably destroy as much as a square foot of well populated flat per day. Since horseshoe crabs were very numerous it became apparent that clam farming could not possibly be successful until methods of protecting beds could be devised. The problem of horseshoe crab control is now under investigation.

It would appear that the prospect of developing clam farming in New England is promising. Municipalities are becoming less resistant to leasing barren flats. There is a plentiful supply of seed stock in the extensive polluted areas which will rapidly purify itself after being transplanted in clean flats. Surface treatment to induce setting also shows promise. If methods of controlling predators can be devised, it is entirely possible that the clam farmer may be able to expect the same success as the oyster grower has enjoyed for many years.

A STUDY OF DUCK FARM POLLUTION OF A SHELLFISH AREA

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M. H. Bidwell and C. B. Kelly
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Under the provisions of the Conservation Law of the State of New York, shellfish sanitation is a function of the Conservation Department. The chief problems of shellfish sanitation consist of: (1) the determination of safe production areas from which shellfish may be taken for food without danger to the public health, and (2) the inspection of plants opening or packing shellfish to assure the continued safety of the product being shipped.

This paper deals with the study which has been made of one small area of Long Island for the purpose of deciding its potential safety as a source of production. The area in question is known as the Peconic, Reeves, and Flanders Bays area. It consists of about 3,500 acres from which some oysters and large quantites of hard clams are produced annually.

The usual procedure of studying an area of this type for the purpose intended is to consider two main factors: (1) the sanitary survey of the watershed, and (2) the results of laboratory examination of samples of water for the presence of organisms indicating pollution.

The Sanitary Survey

The Peconic River is about 12 miles long with approximately 40 square miles of watershed. The average daily run-off of fresh water from this watershed is estimated at about 40 M. G. The watershed is sparsely settled and is mostly farm and woodlands. The river is a fresh water stream above the village of Riverhead. Sources of human or industrial pollution in this part of the river are insignificant. There are, however, a number of duck farms along the river and its tributaries contributing pollution. The pollution from these latter sources is greatly intensified during the Summer when duck production is at its peak.

In addition to the fresh water entering these bays, they are subjected twice a day to the influence of some 4,500 M.G. of clean salt water due to the rise and fall of about 4 feet of tide. The tidal waters enter this area from the east and the fresh water from the west.

The tidal areas are subject to some pollution of human origin in and around Riverhead. The village of Riverhead has a public sewerage system and

treatment plant and discharges effluent about halfway between the village and the mouth of the river. The treatment plant was placed in operation about 1938. It is an activated sludge plant of modern design and of adequate capacity. Samples collected at various times indicate that it is well operated. Typical results are as follows:

Results at Riverhead Sewerage Treatment Plant
September 27, 1948.

	Raw	Prim.Eff	% Removed	Final Eff	% Removed
Total Solids	894	417	54	304	66
Suspended Solids	616	106	83	24	96
B.O.D.(5 day-20°)	500	350	35	48	90

Coliform in Effluent - Maximum M.P.N. per 100 ml.	330
Total Bacteria in Eff. -- " per ml.	610

The river also receives the discharge from a laundry at Riverhead. Admittedly, the discharge of untreated laundry wastes may have some effect on the river and may be a violation of the Conservation Law. Serious damage to the river from this source, however, has not been demonstrable by laboratory tests.

The greatest source of pollution of this area is the numerous duck farms located at various points along the river and near its entrance to the bay. These ducks are of the White Pekin variety and grown in large numbers during the Spring, Summer, and early Fall. Only a relatively few ducks are kept on the farms for breeding purposes during the winter months. A survey of duck farms made by this Unit in 1937 indicated some 21 farms producing more than 1,000,000 ducks annually contributed pollution to this area.

The sources of pollution tributary to this area may, therefore, be summarized in order of their importance as follows:

1. The duck farms, especially in the Summer.
2. Miscellaneous sources of human pollution in and around Riverhead.
3. The Riverhead Laundry.
4. The effluent from the Riverhead Sewage Treatment Plant.

Laboratory Results

Samples of water have been collected from this area many times, and under various conditions, since 1937. Fourteen (14) separate surveys have been made during these studies. It is the usual procedure to collect four samples at each sampling station -- one at each quarter stage of the tide. These are examined for coliform organisms and total bacteria.

Results of these surveys show that in the Spring the pollution is restricted to those waters adjacent to the

duck farms. During the Summer, this pollution extends throughout the entire area and even into Peconic Bay. In the Fall, it recedes to the immediate duck farm locations.

Chart I shows a twelve-year summary of coliform results in this area. It is interesting to note, particularly, the vast extent of polluted waters in the summer months.

Based upon these studies, the Department has adopted a policy of closing the entire area during the Summer and allowing the use of most of the area, except around the months of the River and Meeting House and Sawmill Creeks, during the winter months.

The Sanitary Significance of the Findings

It has generally been accepted in the past that pollution of animal origin was not as potentially dangerous as pollution of human origin. Recent studies of the relationship of pathogens to coliform in duck polluted waters, however, would seem to require a revision in this thinking. It appears quite obvious from these studies that duck pollution may have considerably greater importance from a public health angle than was previously assumed. The balance of this paper will be devoted to the discussion of this particular aspect of the problem.

Discussion of Sanitary Significance of Pollution from Ducks.

Although there is no record of the presence of the typhoid organism ever having been isolated from waters tributary to duck farms or from duck "droppings" themselves, there is quite an extensive literature on the isolation of many members of the paratyphoid group now generally known as Salmonella. This group of organisms is capable of producing quite wide-spread and rapidly progressing outbreaks of intestinal disease which, in many respects, resemble typhoid fever -- the death rate from these outbreaks extending to something in the order of 6%. On the establishment of the presence of Salmonella in domestic ducks, Edwards[1] reports on 56 outbreaks of Salmonelosis in ducks, from which 13 types were isolated. All of these types are recorded by Seligman[2] and Edwards[3], of the National Salmonella Centers, as having at sometimes been associated with outbreaks in humans. The pathogenicity of Salmonella originating from ducks is further demonstrated by Mallam[4], Scott[5], and Snapper[6], who cite cases of human Salmonellosis resulting from the ingestion of ducks' eggs or products prepared from ducks' eggs.

Of particular significance from the standpoint of pollution is the method of infection of these eggs. Both Mallam and Scott agree that the eggs become infected either by introduction of contaminated material into the oviduct during copulation, or by direct contact of the egg with contaminated fecal material on the ground. Thus, the prime origin of Salmonella in eggs is <u>fecal material</u>. These observations are also confirmed by Solowey[7] who found that eggs with adhering fecal material were infected with Salmonella more often than clean eggs. The infection could not be attributed to contamination during the opening since pre-washing in heavily chlorinated water, or wet or dry scrubbing did not reduce the incidence of infected eggs. Although Hilbert[8] reports that Salmonellosis is not a major factor among flocks on Long Island, he does report occasional S. anatum infections. Further, there is no reason to believe that the situation is any different from that prevailing in other parts of this country and in Europe in which the ducks are rather heavily infested with Salmonella. Hansen[9] reports a 5% infection; Clarenberg[10] reports at least 1%. Further evidence available from the literature certainly indicates that ducks should not be excluded from the statement of Edwards[11] that "birds constitute the greatest reservoir of paratyphoid infection among domestic animals."

In order to place the responsibility for the pollution of these bays more directly on ducks, there remains only the necessity to demonstrate the possibility of transmission of these pathogens by water and the question of the degree of survival of the pathogenic organisms as compared to the index organisms, the coliform group.

Attempts have been made in this laboratory to isolate Salmonella from discharges of duck farms and to trace these Salmonella downstream through the heavily polluted areas into the moderately polluted and reasonably clean sections. Results of these investigations will be found in Tables I, II, and III. It will be noted that efforts were concentrated in Flanders Bay and, more particularly, in Meeting House Creek. This area was chosen primarily because of its proximity to shellfish grounds and to the rather heavy pollution emanating from the duck farms in the area, and also because there is little, if any, pollution of human origin associated with these discharges. It was not difficult to recover viable strains of Salmonella from either branch of Metting House Creek, and all types of Salmonella recovered are listed by Seligman[2] as having been associated with many outbreaks of human Salmonellosis. It was also possible to recover Salmonella from the water a quarter of a mile below these discharges, but of more significance is the recovery of Salmonella from a specimen of oysters taken from a private oyster bed which, during the winter, is considered of satisfactory sanitary quality.

Possible Solution of the Problem

It has been shown that duck farm pollution is menacing extensive areas of productive shellfish grounds. The New York State Conservation Department is not content with having found this condition to exist and closing the affected areas to shell fishing. It is believed that the source of this pollution can and must be corrected.

Analyses of the wastes from these farms and preliminary experimental work indicate that the simplest methods of treating sanitary sewage--namely, plain settling for, perhaps, one (1) hour and chlorination--will be effective in substantially correcting this condition and that it can be done at a cost well withing reasonable limits.

Therefore, for the immediate future, the Department will maintain seasonal closed areas as indicated by the surveys and try to interest one or more duck farmers in cooperating in the development of a waste treatment plant, the operation of which may be observed and thus find the ultimate solution to this problem -- i.e., the elimination of the pollution.

CONCLUSION

In conclusion, it appears from the studies made of duck farm pollution of shellfish areas that:

1. Pathogenic organisms are present in water discharged or flowing from duck farms.
2. Such organisms -- potentially dangerous to man -- have been recovered in shellfish taken from water polluted by duck farms.
3. Therefore, public health agencies in charge of shellfish sanitation must give as much consideration to the presence of excessive numbers of coliform organisms originating from duck farms as they would if such organisms were of human origin.
4. That elimination of this pollution by reasonable and economical means appears possible, and is certainly necessary in the public interest.

TABLE I

ISOLATION OF SALMONELLA FROM WATERS TRIBUTARY TO DUCK FARMS

Date	Station	Coliform M.P.N.	Salmonella Isolated	Volume of Sample
8/2/48	5.1, Flanders	4,600,000	S. bredeney, S. give	10 ml.
6/8/48	5.2, Flanders	2,400,000	S. bredeney	10 ml.
6/15/48	5.2, Flanders	930,000	S. bredeney	100 ml.
8/2/48	5.2, Flanders	4,600,000	S. bredeney	10 ml.
9/27/48	5.2, Flanders	2,400,000	S. bredeney	10 ml.
7/12/48	5.2A, Flanders	930,000	S. typhi-murium, S. bredeney	10 ml.
7/12/48	Oyster 4.1, Flanders	24,000	S. typhi-murium	10 ml.
9/27/48	Saw Mill Creek	11,000,000	S. Typhi-murium	10 ml.
9/27/48	Saw Mill Creek	460,000	S. typhi-murium	10 ml.
6/8/48	8.6 Peconic River	2,100	S. bredeney, S. anatum	10 ml.

TABLE II
ISOLATIONS OF SALMONELLA FROM WATER DISCHARGED FROM DUCK FARMS IN MORICHES BAY AREA

Samples Collected May 10, 1949.

Sample #	Farm	Coliform M. P. N.	Salmonella Isolated	Volume of Sample Tested
18135	A	9,300,000	S. anatum	10 ml.
			S. typhi-murium	10 ml.
18136	B	9,300,000	S. meleagridis	100 ml.
			S. bredeney (4 isolations)	10 ml.
18137	C	930,000	S. typhi-murium	10 ml.
18138	D	15,000,000	S. typhi-murium	10 ml.
18139	E	2,400,000	none isolated	100 & 10 ml.

TABLE III

INCIDENCE OF SALMONELLA TYPES ISOLATED IN INFECTIONS OF MAN AND DUCKS

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Type	Man Edwards[1] No. Outbreaks	No. Cases	No. Fatalities
Total - All Types	1677	2949	56
S. typhi-murium	357	469	12
S. derby	49	126	1
S. bredeney	16	34	0
S. panama	73	124	4
S. give	36	75	0
S. anatum	64	165	1
S. meleagridis	16	43	0

Type	Man Seligman[2] No Outbreaks	No. cases	No. Fatalities	Ducks Edwards[3] No. Outbreaks
Total All types	941	1107	57	56
S. typhi-murium	307	356	22	32
S. derby	34	37	1	1
S. bredeney	4	4	0	2
S. panama	46	57	1	1
S. give	17	17	0	2
S. anatum	49	64	1	8
S. meleagridis	13	13	0	0

* * * * * * * * * * * * * * * *

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2. E. Seligman, I. Saphra, and M. Wasserman
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J. Immunology 54 69 (1946)

3. P. R. Edwards, O. W. Bruner, and A. B. Moran
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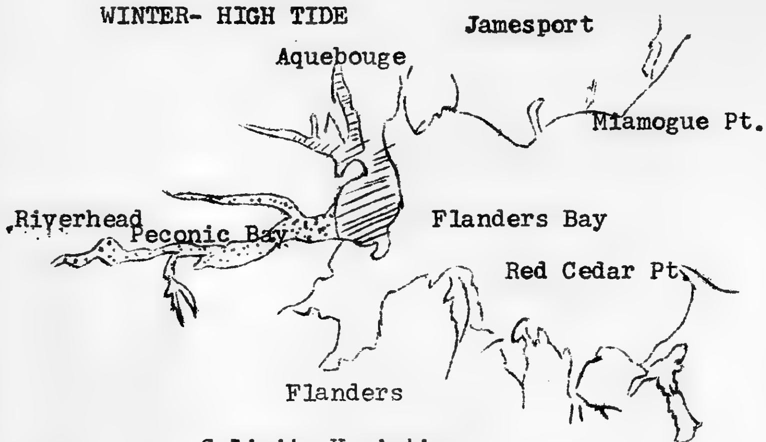
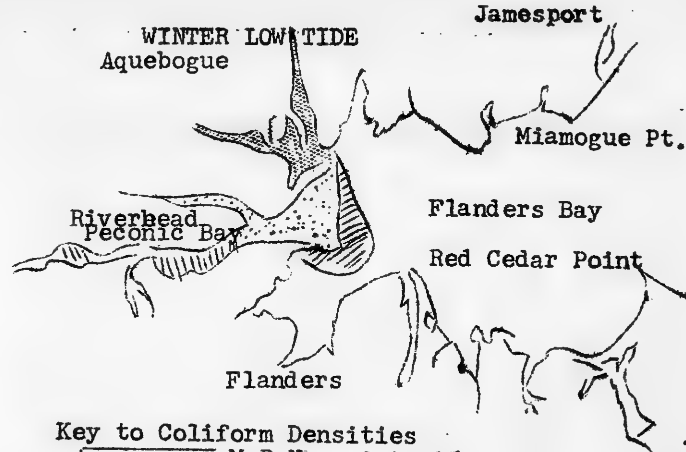

WINTER- HIGH TIDE
Jamesport
Aquebouge
Miamogue Pt.
Riverhead
Peconic Bay
Flanders Bay
Red Cedar Pt.
Flanders


WINTER LOW TIDE
Jamesport
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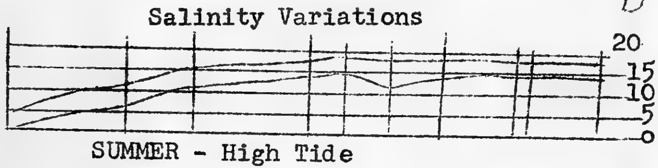
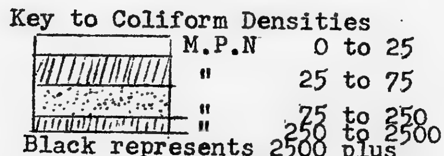
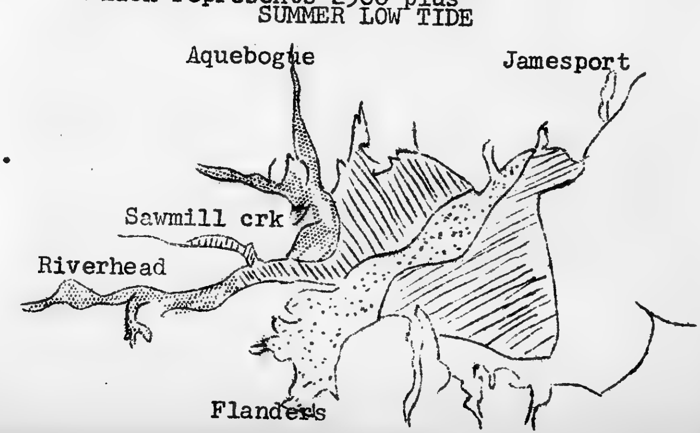
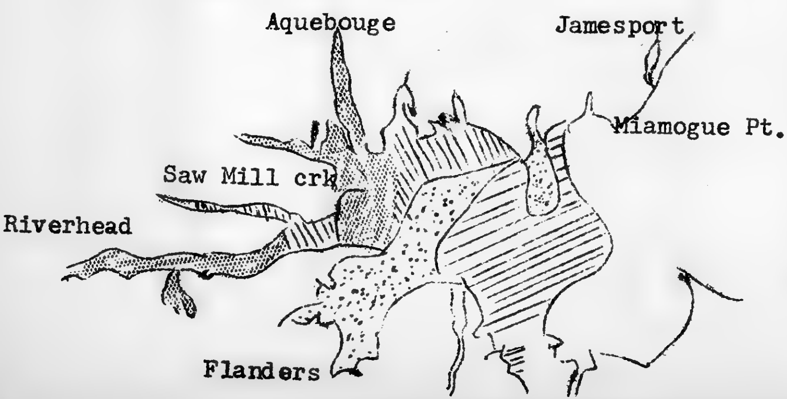
Riverhead
Peconic Bay
Flanders Bay
Red Cedar Point
Flanders


Salinity Variations
20
15
10
5
0
SUMMER - High Tide


Key to Coliform Densities
M.P.N 0 to 25
" 25 to 75
" 75 to 250
" 250 to 2500
Black represents 2500 plus


SUMMER LOW TIDE
Aquebogue
Jamesport
Sawmill crk
Riverhead
Flanders


Aquebouge
Jamesport
Miamogue Pt.
Saw Mill crk
Riverhead
Flanders

PRELIMINARY OBSERVATIONS OF THE PREDATION OF COMMERCIAL SHELLFISH BY CONCHS

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INTRODUCTION

Baymen from many estuaries along the northeastern coast of the United States credit the conchs (*Busycon carica* and *B. canaliculatus*) with severe predation of oysters on native bay bottoms. Thus conchs captured by them in their tonging and dredging operations are thrown up on banks to perish or are destroyed in some other way. Colton (1908), an early investigator of bivalve predation by these conchs, from observations of these snails in marine aquaria, concluded that they may not be as serious a pest to the oystermen as previously reported. In view of this variance, it seemed desirable to make further investigations which will ultimately indicate the extent of such predation, particularly on commercial shellfish. The present report is concerned with a study of conchs in captivity; studies of the conch in its native habitat are anticipated for the coming summer.

METHODS

These studies were begun in the fall of 1947 and were carried out in the Rutgers University Vivarium in a number of 10 gallon marine aquaria. These tanks were connected in series with large siphons permitting the circulation of the sea water by means of a simple air lift pump placed at one end of the chain of aquaria. Further aeration was provided by the release of compressed air into each tank through thin cross sections of wooden dowel. Sand used in some of the aquaria was obtained at a local ocean beach. Clean bay water was collected in Shark River Basin, and in the Vivarium aquaria ranged in salinity in the course of the observations from 26.4 to 28.5°/oo. Water temperatures ranged from 63 to 77°F. Hydrogen ion concentration was found to drop after a time from approximately 8.0 to 6.0 as organic wastes accumulated in the water; sodium bicarbonate was added to return the pH to approximately 7.5. No filter was required in the circulating sea water system since the numerous shellfish used to feed the conchs provided excellent natural filtration. Six conchs, 4 knobbed (*B. carica*) and 2 channeled (*B. canaliculatus*) collected in Great Bay, N. J., and in Peconic Bay, Long Island, N.Y., were used in the study. The conchs ranged in length from 2.7 to 6.2 inches and during the course of the observations in the last year added a maximum of 0.5 inch of shell at the outer lip. Conditions in the aquaria were sufficiently favorable to permit oysters

and quahaugs to add as much as 0.2 inch of new shell. The shellfish used in feeding the conchs were obtained in Shark River, with the exception of the oysters which were collected in Delaware.

OBSERVATIONS

METHOD OF PENETRATION OF SHELLFISH BY THE CONCH. Copeland (1918) has shown that the conch responds very quickly to the blood of a fresh oyster. This marked response is observed again in the readiness with which a conch will locate an oyster or even a clam buried in the sand in an aquarium. The snails creep at a relatively fast rate, attracted by the water pumped from the excurrent siphon of the bivalves. Nor are shellfish such as quahaugs which normally occur buried shallowly in the bottom, safe, since conchs readily dig them out. It is not known whether they can dig up such deeply buried molluscs as adult clams.

Colton (1908) observed that these conchs will penetrate and consume such shellfish as quahaugs, mussels, oysters, razor clams and soft clams. Magalhaes (1948) found that in North Carolina these conchs consumed 8 additional kinds of shellfish. Colton's findings were confirmed in the course of the present observations. It was also noted that they consume such molluscs as the soft clam (Mya arenaria), in which portions of the soft parts are unprotected by the valves, merely by tearing out the flesh bit by bit until the valves are clean. Such thin-shelled bivalves as the edible mussel (Mytilus edulis) are enveloped by the foot of the conch to the extent permitted by the size of the conch foot and of the mussel, leaving the portion of the mussel valves farthest from the hinge exposed and oriented directly under the outer lip of the snail shell. The conch by contracting the columellar muscle (that muscle connecting the foot with the shell at a point within the shell spire) then very slowly and forcibly brings its outer lip to bear between the bills of the mussel. This pressure either forces apart or chips off a portion of the valves. The curvature of this part of the conch shell aids in spreading the mussel valves, and the concavity of the valves leaves a ready entrance for the conch proboscis. In one experiment 3 conchs were placed in an aquarium with an assorted collection of shellfish. Within 10 minutes each of the conchs had a mussel enclosed in its foot; 4 1/2 hours later the 3 conchs had opened and consumed 7 mussels (0.9-1.2 inches long), 1 clam (0.8 inch), 1 razor clam (2 inches) and 1 quahaug (1.6 inches). Throughout, the conchs showed a decided tendency to prey upon the thiner-shelled molluscs first.

As Colton has pointed out and as confirmed in these observations, the conchs readily attack oysters. A conch creeps onto one valve of an oyster, again, in such a manner as to bring the outer lip of its shell directly over the bills of the oyster. The oyster at first closes its valves tightly, then opens them gradually, inadvertently permitting the conch to thrust its shell between the valves. The curvature of the conch shell when pressed between the oyster valves pries the valves apart; the conch then introduces its proboscis under the protection of its own shell and eats its fill. Inspection of oysters opened by conchs in many instances reveals very little if any detectable chipping of the bills. If a portion of the oyster valve is broken away, a conch will not attempt to pry the valves open but will introduce the proboscis directly. The ventral surface of the foot of the conch secretes a highly viscous mucus while attached to prey and this may play a part in the great effectiveness of the conch foot in retaining its hold. Magalhaes incorrectly suggests that this mucus is probably saliva. A conch once attached to a bivalve is not easily driven off. In these experiments bivalves to which conchs were adhering were moved about, and the conchs themselves were handled, with no effect on the conchs other than to cause them to bring their shells down more closely over the foot. From the point of food conservation, the method of feeding employed by conchs has much in its favor, since in small bivalves the snail foot almost entirely envelopes the bivalve so that none of the flesh is lost and potential poachers are kept away. In the case of larger bivalves, although the foot does not entirely envelope the animal, the conch's shell is wedged between the valves thus affording considerable protection against raids by other animals.

Of all shellfish, the quahaug-like bivalves offer the greatest resistance to the predation of conchs, and yet these are also readily opened and consumed. It is in the penetration of the quahaug that the conch displays best its highly specialized mechanical method of opening shellfish. The conch mounts the quahaug and holds it, as Colton expressed it, "in the hollow of its foot", so oriented that the bills of the quahaug lie directly under the outter lip of the conch shell. Then the conch, by very slowly and strongly contracting the columellar muscle, brings the margin of its own shell to bear on the slight depression present between the junction of the two quahaug valves, and presses against the edge of the quahaug valve farthest from it. Such pressure is sufficient to chip a portion of the quahaug valve away. The conch then slowly relaxes its columellar muscle and draws its shell margin back from the bills of the quahaug. This slow chipping away of the quahaug bills continues until an opening of sufficient size is made to permit the conch to wedge its shell margin

between the quahaug valves. Warren (1916) recorded a rate of chipping of 6 times per minute. During this chipping attack the conch occasionally ceases its slow hammering to check the extent of damage inflicted: the rim of the anterior portion of the foot, held just under the bill of the valve to which the conch is attached, is brought over the damaged area and numerous tiny lobe-like projections of this rim are passed back and forth over the erroded shell as if in examination. If the pressure from the conch is severe enough to crack off a large opening, as often happens, or if one or both of the quahaug valves crack from the pressure exerted by the quahaug in an attempt to keep its valves closed, as occasionally happens, the conch makes no attempt to wedge its shell between the valves. However, more commonly it takes repeated chipping to expose a small opening. The conch attempts to wedge its shell between the valves as soon as an opening sufficiently large to permit penetration is chipped. Some victims, for example, showed chipped holes only 0.197 inch in width. The bluntness of the conch shell margin also determines the size of hole necessary for penetration of the conch shell; and this bluntness varies from time to time as considerable wear of the conch shell takes place during attack. The conch apparently adds new shell during resting periods at which time it generally remains buried in the bottom. Such rest periods have extended as long as 16 days in aquaria. Thus the conspicuous indented nature of the lines of shell growth along the body whorl of the conch shell are explained on the basis of the periodic erosion which occurs during attacks. It happens in some instances that the chipping of the quahaug valves results not in the formation of an opening but in the smoothing off of the quahaug bill, particularly of the valve edge farthest from the conch, and/or in the formation of an opening which is too small to permit wedging. In such cases the conch eventually deserts the quahaug. In one such instance a conch worked alternately between two quahaugs for 7 days without penetrating either, and finally deserted them. Out of 37 quahaugs which were placed with one large conch in one experiment, 15 quahaugs were opened and 10 were attacked but could not be opened. In only 2 cases in these observations did a quahaug victim show two areas of attack, in which apparently the first attack failed, and then the conch returned on a subsequent day in a second attack which was successful.

In 31 quahaugs opened in one series of observations by conchs it was noted that 52% of the sites of attack were located posteriorly over the siphons, 27% over the midventral region, and 21% over the anterior portion of the quahaug opposite the siphon. It is suggested that the selection of the sites of attack may be influenced by the flow from the excurrent siphon of the quahaug.

It was reported to me by members of the crew of the "Quinnipiac" during a trip on Peconic Bay, Long Island, that in the course of examining the material pumped off the bay bottoms and passed down the conveyer they had observed two cases in which large conchs still affixed to quahaugs and with proboscides extended into the quahaugs also had the operculum wedged between the quahaug valves. The use of the operculum in this way has not been observed during these experiments; it may well be a further means of facilitating penetration.

It was interesting to note that although shellfish are helpless against conchs, small sea anemonies on these shellfish are not as ready victims: one oyster on which a conch was creeping held a small sea anemone. As the foot came close to the anemone that portion of the foot nearest the coelenterate was suddenly withdrawn. The conch approached several times, each time retracting. Eventually it passed over the anemone, carefully elevating that portion of the foot over the anemone. Apparently, the nematocysts shot out by the anemone were effective defense.

Colton in his brief description of how quahaugs are opened by conchs, wrote that there are three ways in which penetration is effected: "First, it may flatten out its proboscis so that it will go through the crack; secondly, it may pour in a secretion between the valves which kills the clam; and thirdly, it may wedge its shell between the valves." The first and third ways mentioned by Colton agree with the observations herein reported; however, there is no evidence (nor did Colton present any) substantiating his statement that the conch may pour a secretion into the prey to kill it, nor Magalhaes' suggestion that the conch may initiate digestion externally. On the contrary, there is evidence against such a statement: in some of the attacked but unopened quahaugs, holes as large as 0.4 x 0.47 inch were left and yet apparently no secretion had been poured into the quahaugs since they were vigorous healthy animals weeks later. Some observers believe that the valves of shellfish are pulled apart by suction of the foot. However, Magalhaes has shown that a pull of 4 to 6 pounds is sufficient to dislodge a conch firmly attached to a surface, whereas Reese (1942) has estimated that a force of 23 to 26 pounds is necessary to force open a quahaug.

<u>Extent of Conch Predation on Shellfish in Captivity</u>. In the first feeding experiment all 6 conchs were placed in an aquarium of slate bottom, 23 x 12 inches, covered with about 1/2 inch of sand, in the presence of numerous quahaugs and edible mussels, and a few salt oysters, razor clams and soft clams. The temperature of the water remained in the vicinity of 68°F. and the salinity,

$28^{\circ}/oo$. In the course of 23 days the following shellfish were opened and consumed:

Edible mussels (<u>Mytilus edulis</u>), 0.6-1.6 inches long	69
Quahaugs (<u>Venus mercenaria</u>), 0.8-2 " "	17
Clams (Mya arenaria), 1.4-2.4	3
Razor Clam (Ensis), 2 inches long	1
	90
Shellfish consumed per conch per week	4.5

Conspicuous here is the fact that between the quahaugs and the mussels which were present in large numbers, the conchs made greater inroads on the mussels.

In a second experiment the 5 smaller conchs were placed in the same aquarium with an excess of oysters of various sizes. In a period of 99 days from December 29th to April 7th these conchs opened and consumed the following <u>Ostrea virginica</u>:

<u>Ostrea Size Range. - Longest Dimension</u>	<u>Number Consumed</u>
0.4-0.7 inch	28
0.8-1.1 inch	9
1.2-3.1 inch	22
	59

Or one oyster consumed per conch every 8 days.

In a third experiment the same 5 smaller conchs were placed in the same aquarium with an excess of oysters of various sizes. In a period from April 8th to May 8th for the 5 smaller conchs, and April 25th to May 8th when the larger conch was added to the tank, or a total of 163 conch days, these conchs opened and consumed the following <u>Ostrea virginica</u>:

0.4-0.7 inch	33
0.8-1.1 inch	18
1.2-2.6 inch	12
	63

Number of oysters consumed per conch per week 2.7

The threefold increase in consumption of oysters in the second period may be attributed to the increase in the temperature of the water. In the first oyster experiment above the temperature of the water remained between 64 and 68°F., whereas in the second experiment the temperature remained between 68 and 75°F., or higher.

In a fourth and final experiment it was hoped to check the extent of predation of quahaugs that were permitted to bury in sand, since in the previous experiments the shellfish were lying directly on the bottom, exposed to the conchs. The largest conch (<u>Busycon carica</u>) was placed alone in an aquarium with slate bottom 2 x 1 feet in area covered with approximately 2.5 inches of beach sand. Thirty-seven quahaugs

varying in length from 0.8 to 3.0 inches (nicks to chowders) were allowed to bury in the sand of the aquarium. In a period of 131 days, from December 15th to April 25th, the conch opened and consumed 15 quahaugs ranging in length from 1.3 to 2.2 inches or one quahaug consumed per conch every eight days. In this same period eleven detectable unsuccessful attacks were made on quahaugs. If this figure is added to the 15 quahaugs consumed, the consumption per conch becomes one quahaug every 5 days.

CONCLUSIONS AND SUMMARY

It can be agreed with Colton and Magalhaes then that these conchs do prey upon a variety of shellfish; and with minor exceptions it can be said that Colton's brief description of the method of penetration employed by the conchs fits the observations herein reported. The extent of predation on quahaugs, oysters and edible mussels, as studied under artificial conditions, is, however, of much greater potential consequence than Colton's report would indicate. Final conclusion will come from actual field studies.

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TOXIC EFFECTS OF OIL MIXED WITH CARBONIZED SAND ON AQUATIC ANIMALS.

-by-
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(A paper presented at the Annual Meeting of the National Shellfisheries Association at Old Point Comfort, Virginia, on June 9, 1949.)

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Oil pollution of inshore coastal waters is a problem of major importance for the conservation of our quatic resources. Aside from being destructive to aquatic animals and plants, oil and other organic liquids floating on the water are a great nuisance to such recreational activities as boating and bathing and create a serious fire hazard, especially around piers and other structures built of creosoted wood.

After a damaging fire at the Norfolk Naval Shipyard, resulting from the accidental ignition of oil floating on the water, the Chemical Laboratory of the shipyard undertook a comprehensive study of the existing methods of removal of oil slicks and began a search for better ones. The experimenters of the Navy found that a carbonized sand can be prepared simply and cheaply by roasting creosote and sand in a specially designed kiln and that this has remarkably good organophilic and hydrophobic qualities. The sand, with its carbon coating, is sprayed on the surface of an oil slick. Coming in contact with oil, the carbon coating forms a stable bond with the oil. The mixture may then be readily removed. If on the surface of the water, the combined sand and oil may be sunk by a stream of water under pressure or by some other method of agitation. The bonding of the oil and carbon surface of the sand is permanent and an oil slick thus treated remains anchored on the bottom.

A popular account and graphic story of this new way of removal of oil slicks appeared in "Life" (1947, Vol. 23, No. 19). The caption to one of the photographs accompanying this article stated that the submerged sludge "is lethal to most marine life". Since there was no corroborative evidence of thetoxicity of oil bound by carbonized sand, the United States Navy, through its Bureau of Ships, asked the cooperation of the Fish and Wildlife Service in a study of the problem. The present report summarizes the results of the experiments conducted in compliance with this request.

Oils discharged into coastal waters do not remain floating indefinitely. They are absorbed by particulate matter suspended in the water. Agitation of the water by currents and wave action helps the settling of the oil-saturated material on the bottom, but the oil slick is not securely fixed and may be carried to

distant places. This characteristic behavior and its importance in aquatic life has been emphasized by Nelson (1925) and Gowanloch (1925).

Injury caused to ducks and other water birds by oil floating on the water is well-known, since many instances have been recorded of the finding of oil-smeared birds unable to fly (Lincoln, 1936; Adam, 1936). Likewise sedentary animals living within the tidal zone and coming in direct contact with oil may be destroyed.

The toxicity of oil in sea water, due to water soluble substances extracted from oil has been demonstrated many times experimentally using fishes and marine invertebrates. (Seydel, 1913; Nelson, 1925; Roberts, 1926; Gardiner, 1927; Ministry of Transport and the Ministry of Argiculture and Fisheries, Joint Committee on Damages to Fisheries, 1930; Gowanloch, 1934; Galtsoff et al., 1935; Galtsoff, 1936; Veselow, 1948; and others).

Since there is convincing evidence of the leaching out of toxic substances from oils present in sea water, it is desirable to ascertain whether the combination of oil with carbonized sand would alter this action. The combination may either lessen the toxicity of the oil, or it may increase it by bringing the poisonous oil closer to the bottom-dwelling forms, permanently anchoring it there, and allowing a slow and continued extraction.

For our study we selected for experimental animals such forms that would normally live attached to submerged objects, or on the bottom in estuaries and harbors where this type of pollution is most apt to occur. We chose in particular animals of known economic importance, but also included others which aptly land themselves to the experimental procedures desired. We used the following organisms: the hydrosoan Tubularia crocea, which grows attached to pilings and docks; the barnacle a very common form growing abundantly on rocks and structures near low tide mark; the embryos of the toadfish Opsanus tau, one of the common bottom-dwelling fishes in harbors and bays which attaches its large eggs to wood, rocks, and other submerged objects; the hard shell clam Venus mercenaria, which inhabits the mud flats; and the oyster Ostrea virginica, found on rocks and on the bottom in all coastal waters.

The oils tested were supplied by the Navy. these included crude oil, Navy Grade Special Fuel Oil, lubricating oil (SAE 20), and Diesel oil.

Because of the necessity of making this paper short, only a brief summary of the many experiments performed can be presented. A more complete description of the experiments and the results obtained in each is soon to be published.

EXPERIMENTS WITH TUBULARIA CROCEA

Weakend or dying polyps of Tubularia lose their dark pink color and become slightly opaque. Their tentacles fail to respond to touch and, finall, the entire hydranth, with its whorl of filliform tentacles, separates and drops off, leaving dense tufts of tangled stems. This characteristic change makes it convenient to employ colonies of Tubularia as test animals. The death point of an individual hydranth may be takne as the time when it drops off the stem and the progress of mortality in the group can be easily expressed in the number of lost hydranths.

The tests made with Tubularia consisted in determining the survival of this organism in standing or in running sea water containing known quantities of mixtures of various oils and carbonized sand, and in its survival in water to which an extract of crude oil was added. Relatively dilute concentration of oil or oil mixed with carbonized sand were toxic to Tubularia in standing solutions, a strenght of 1:1000 killed about 33% within 24 hours. Apparently there is sufficient toxic material leached out in a short time to be deleterious to this organism. When this is made more dilute by a flow of sea water, the injuriousness is less pronounced. With a flow of 65 to 75 liters per hour a toxic effect becomes apparent after 48 hours if 5 ml. or more of oil mixed with sand are placed in the immediate vicinity of Tubularia in a 2-liter jar.

The results comparing different oils show that lubricating oil was least toxic, while crude oil appeared to be the most toxic. The toxicity of the crude oil apparently resulted from something leached from the oil by water, for extracts were found to be toxic to Tubularia.

EXPERIMENTS WITH BARNACLES, Balanus balancides(Ag.)

Adult barnacles can be conveniently used in toxicological tests. The barnacles can be easily arranged in a desired position in the experimental set-up. The effect of a toxic substance can be studied by observing and timing the sweeping of their cirri. In running sea water or in containers in which the water is renewed daily, they remain active and apparently in good condition in the laboratory for many days and weeks.

The test performed clearly demonstrated the toxic effect of crude oil and sand mixtures placed in the immediate vicinity of barnacles. A slowing of the cirri

was observed within 6 hours in the weakest concentration tried, 1:50. Poisoning was progressive and complete death of 80 to 90% of the barnacles took place within 70 hours.

EXPERIMENTS WITH TOADFISH EMBRYOS, <u>Opsanus tau</u> Linn.

Toadfish embryos present excellent material for bioassay; they are large, fairly transparent, and are attached by egg membranes to pieces of wood, stone, shells, and similar objects. Normally they are quite active in the laboratory jars and the beating of their hearts and the circulation of blood can be easily observed with adequate illumination and suitable optical equipment.

Crude oil mixed with carbonized sand was found to be quite toxic. Even the lowest concentration of 1:200 was sufficiently toxic to kill all the embryos in 11 days. The mortality of embryos in water with greater quantities of oil was more rapid. If the log of the survival time is plotted against the log of concentration, the toxicity curve approximate a straight line. The linear relationship obtained by such plotting can be approximately represented by a general equation of type $\underline{y = a\ x^c}$ and the constants a and c may be computed from the empirical data.

The relative toxicity of the different oils mixed with carbonized sand was ascertained. Crude oil added in the ratio of 1:40 killed three out of five test embryos within 47½ hours. Toxicity of Diesel oil was noticeable within 52 hours in the concentration of 1:20, while lubricating oil was ineffective even in the concentration of 1:10 (50 hours).

EXPERIMENTS WITH HARD SHELL CLAMS, <u>Venus</u> <u>mercenaria</u> Linn.

The hard shell clam, chosen for experiments because of its economic value, is frequently found in polluted bottoms of harbors and bays. Because of their ability to close themselves within their shell, clams, like oysters, are capable of slowing down their activities to a low minimum for rather protracted periods of time. In this way they may reduce the immediate effect of unfavorable conditions.

In the one experiment performed, the sea water supply to the clams flowed at the rate of 21 liters per hour through containers containing 20 ml. of an oil or an oil and sand mixture. None of the clams died during the 12½ days of the test in the sea water containing crude oil, fuel oil, Diesel oil, or lubricating oil or mixtures of these oils with carbonized sand. There was no evidence of their weakening.

EXPERIMENTS WITH OYSTERS, Ostrea virginica gm.

Because of its great economic importance, the oyster has been studied more than most marine invertebrates. Consequently its physiology, habits, and life history are better known than other lamellibranchs. Living attached to rocks or lying on the bottom it is frequently affected by oil wastes discharged into waters. Having no means of moving from unfavorable environments, the oyster protects itself by tightly closing its valves. If the inimical condition persists, the oyster is eventually damaged or killed.

Tests of the toxicity to oysters were made of standing water to which were added crude oil in a dilution of 1:500 and Diesel oil in strengths of 1:200, and similar strengths in which the oils were sunk to the bottom mixed with carbonized sand. In the test with Dissel oil the first death occurred on the third day with an oil layer on the surface, and on the fourth day in the aquarium with the oil and sand mixture. By the end of the test on the 13th day, the mortality was 67 per cent in the test with oil on the surface against 25 per cent with the oil treated with carbonized sand. There was no mortality among the control oysters. Experiments with crude oil added in the ratio of 1:500 gave similar results. In these first death was observed in the ninth day and the mortality was less pronounced, due probably to the small quantity of oil used.

In experiments with oysters kept in large tanks of running sea water and exposed to a mixture of crude oil and carbonized sand, no toxicity was observed in 35 days of the test. It was found that 500 ml. of oil introduced into a water system running at the rate of 180 liters per hour and anchored by carbonized sand were insufficient to cause mortality or to inhibit the growth of the shells of adult oysters.

The maintenance of a steady flow of water through the gills of an oyster is essential for its feeding and respiration. The measurement of the rate of filtration of water is a very sensitive means of studying the effect of changes in the environment of the oyster, for the organism rapidly reacts to the presence of toxic substances which may be introduced into natural waters. Methods are available at present for measuring the efficiency of the ciliated mechanism concerned with pumping alone or for obtaining the overall picture of the function of the entire pumping system involving also the mantle and shell. Experiments were performed with each method, the former known as the carmine-cone technique and the latter the apron method (see Galtsoff, et.al., 1947).

It is impossible in this short paper to describe in detail the numerous experiments performed and the results observed using the various oils, these oils

mixed with carbonized sand, and extracts of these oils in experiments in the physiology of oysters. We conclude from the various tests we performed that there was a realease of physiologically active substances which suppress the activity of the ciliated epithelium of the gills of the oyster and that the anchoring of oil by carbonized sand does not prevent this release.

S U M M A R Y

We found that crude oil, Diesel oil, and Navy Grade fuel oil added to sea water are toxic to the various animals normally inhabiting estuarine environments, the more sensitive forms being killed rather promptly when compared to the forms known to be more hardy. The toxicity of these oils is apparent whether they are present as oil slicks on the surface of the water or are held on the bottom bound to carbonized sand. This toxicity results from material leached out of the oil by water. The oyster responds to relatively weak concentrations of the toxic materials leached from oil by a marked reduction in the amount of water filtered for respiration and feeding and a decrease in the number of hours open.

There is definite advantage in the use of carbonized sand in treating oil slicks for its localizes the oil pollution, prevents the spread of oil over the surface of water, and submerges and permanently anchors the oil near the source of pollution. In view of the fact that bottoms of harbors and bays near inductrial ports are grossly polluted and non-productive, the sinking of oil in these localities will not increase the damages to the fisheries.

Dusting with carbonized sand is a highly efficient method of removal of oil from the surface of the water. It is useful around docks and piers to combat fire hazards and also has distinct advantage in preventing the movement of oil slicks to productive areas where great injury to sea food resources may occur. We hope that the method will be adapted in some way to have more general use in combatting oil pollution in coastal waters.

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Some Addresses

Given at

1949 JOINT ANNUAL CONVENTION

Oyster Growers & Dealers Association of North America, Inc.
Oyster Institute of North America
National Shellfisheries Association

Chamberlin Hotel, Old Point Comfort, Virginia, June 7 - 9

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HISTORY OF THE OYSTER GROWERS AND DEALERS ASSOCIATION OF NORTH AMERICA, INC.

Joseph N. Thompson

Chamberlin Hotel, Old Point Comfort, Virginia, June 8, 1949

A couple of years ago the Elks held a Convention in Salamanca, N. Y., a town near Lake Erie. To the Convention they invited all the Townsfolk because they were going to have a great Orator from New York City address them.

Never having heard a great orator before, the Townsfolk packed the Community Hall to the rafters. When the great orator arrived he was escorted down the central aisle to the stage amidst thunderous applause. When he started delivering his oration he had a peculiar habit of keeping his eyes shut and walking up and down the stage, and kept doing this all through the oration till he finished.

To use a Shakespearean expression, the speech was the "lousiest" the townsfolk, including the Elks, had ever heard. So while he was talking they gradually silently filed out. When the great Orator finished he opened his eyes and saw only one man in the audience. He said to the man "Where has the audience gone?" and he replied, "Why they filed out long ago." The orator said, "What the Hell are you doing here?" and the man replied, "I am the next speaker."

Well I hope you will not disappear during my speech, because there is a real Orator and Humorist succeeding me - Colonel Houston - whom I have listened to for over 25 years, and I know you will be well rewarded for your patience.

Be that as it may to the knowledge of the writer, he is the only man living who was present at the Organization Meeting of the Oyster Growers and Dealers Association of North America, and who has been a member ever since. This apparent, unusual circumstance was due to his being from ten to twenty years younger than anyone else present, and not that I am an octogenarian.

Because of this fact, I was asked by Jim Darling and Dr. Radcliffe at the last Convention to write a short history of the founding, and of the development of this unique and wonderful Organization over the past 41 years of its existence - two wars to the contrary, notwithstanding.

Unfortunately, as I kept no notes, the facts I relate will be just from memory and therefor necessarily limited in number.

It was over 45 years ago that the far-seeing Planters and Shippers of, and Dealers in Oysters were beginning to see that only through unity and cooperation could their mutual interests be advanced and protected.

Previous to that time each locality was a law unto itself, and its members knew very little about what the other fellow in another locality was doing, except when he sold at a lower price. Their world was small like that of the Oyster itself. The problems of one section were practically unknown to another. It was a case of Dog eat Dog, and the Devil take the hindermost.

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As is now evident, such a policy would inevitably lead to chaos. So thought the progressive men in the business at that time, and they decided to do something about it. Consequently, some of the larger Planters resolved to take the initiative and form an Association for mutual protection through exchange of ideas and adoption of measures that would promote the interests of all.

Prominent among these pioneers were Henry C. Rowe of New Haven, Captain Frank Darling of Hampton, Virginia, Rufus Miles and Isaac Ballard of Norfolk, Senator Homans of Rhode Island, R. R. Higgins, and William Atwood of Boston,Massachusetts, Azel Merrell and Henry C. Elsworth of New York City, Andrew Radel, Sr., of Bridgeport, Connecticut, Frank Mansfield of New Haven, Roy Lewis of Bridgeport, William Killian of Baltimore, Ernest Ball of New Haven, N. S. Ackerly of Northport, William Mills of Greenport, William Merwin of Connecticut, Thompson & Cole of South Norwalk, Stanley Lowndes of Northport, Capt. H. I. Reynolds of Wickford, Rhode Island, Jacob Ockers, Fred Ockers, and Henry Vanderburg of West Sayville, Mr. Beardsley of Stratford, Shang Wheeler of Bridgeport, and others whose names have escaped my memory.

The most powerful man in the Oyster business at that time was Henry C. Rowe of New Haven, who owned the largest acreage of oyster ground in the country and the biggest oyster plant. It was he who initiated the correspondence among the various growers that led to the first meeting of the oystermen mentioned above, most of whom attended. It was held at the Old Ashland House, Twenty-seventh Street and Madison Avenue, New York City. At this meeting on or about June 1908, the Oyster Growers and Dealers Association of North America was formed.

The main rival of Mr. Rowe, not as an oyster planter, but as a speaker and organizer, was Senator Homans of Rhode Island, Both men were formidable, but of diametrically opposite temperaments and dispositions.

The former was an introvert, strong, cold, calculating, determined, very capable and aggressive, and of Bull Dog tenacity. The latter was an extrovert, suave, disingenuous, persuasive, sarcastic, and of the rapier type of fighter. Neither one would compromise his idea as to what the policy of the Association should be, and as to how it should be carried out. It was a case of an irresistible force meeting an immovable body. Both wanted to be the first president, but neither one had sufficient adherents to be elected. Hence a compromise candidate was chosen, Mr. Azel F. Merrell of New York City. He reigned about five years and was succeeded by Mr. Henry C. Rowe, who presided for another five years. Mr. Rowe was followed by Mr. William Killian of Baltimore, for about ten years, then Mr. Howard Beach for about thirteen years, who upon his death was followed by Mr. Jim Darling in 1941, until the present time.

The Association's first Vice President, elected in 1908, was Captain Frank Darling, who remained as Vice President until his death in early 1941 and who was succeeded by his son, Jim, for two months, when the latter was elected President. Jim was suceeded by Paul Mercer as Vice President, who still reigns. The original Treasurer was Mr. R. R. Higgins, who held office for about five years and was suceeded by the writer, who was Treasurer for about the same length of time. His successor was Mr. Herbert Brown of New Haven, who held the job for many, many years until his death when Dr. Radcliffe took over.

The first Secretary was Mr. William Atwood of Boston, who was succeeded after four or five years by Mr. Eugene D. McCarthy of New York City, a pseudo-Christian Scientist and the comedian of all Conventions. Many a meeting was thrown into stiches of laughter by his apt witticisms. They always created a pleasant interlude to an otherwise serious meeting. McCarthy remained as Secretary until his death. Later Dr. Radcliffe assumed his duties, and in addition to his many other functions, still holds this office.

In passing, some comments might be made concerning the characteristics of the various presidents who guided the course of the Association since its inception.

The first President, Mr. Azel Merrell, as mentioned, was a compromise candidate. He was made for the job, which at that time was mainly a healing of the wounds between the faction headed by Mr. Rowe and that by Senator Homans. In a new Association, harmony above all was essential to carry it through its early stages, and Mr. Merell accomplished this end with the help of Captain Frank Darling - the father of Jim - who was a great pacificator.

Then when Mr. Rowe assumed the authority, the way had been paved for accomplishment of unity of action and progress along constructive lines. A national advertising campaign, pointing out the indispensability of oysters in the diet of the nation, was immediately instituted and proved very successful. The beginnings of national and state cooperation by the Government in the problems of the Industry were inaugurated. The force that Mr. Merrell lacked and Mr. Rowe possessed was being reflected in the forward strides the Association was making.

Then came Mr. Killian, who was loved by everyone. He came into office before the first World War and successfully carried us through it. There were times, however, when only the Board of Directors met in place of the annual convention, due to war conditions. Because of the war, it might be said that the Association had to some extent retrogressed, and the death of Mr. Killian did not make this situation any better.

During the administration of Mr. Killian a revolutionary change took place in the type of package used in the shipping of shucked oysters. Previous to that time shucked oysters were shipped in a tub with a cake of ice in the center. As the ice melted, the oysters would absorb the water and lose a lot of their natural flavor and properties for which oysters are noted and eaten.

To remedy this situation, a Company called the Sealshipt was organized by a Mr. Brooks and the firm of Hornblower and Weeks, the last gentleman being Secretary of War at that time. They put out a container of galvanized iron in which the oysters were put and sealed in. Such container was inserted in an outer wooden carrier and surrounded with cracked ice, not in contact with the oysters. The carrier and container were to be returned to the shipper after being emptied by the customer and used continuously in this way until worn out.

The Sealshipt Company furnished the customers without any expense to the shipper, except the latter was to buy stock in the Company for the value of the number of carriers used, but a dividend was paid each year on this amount. The shipper was to charge $.10 per gallon extra of the tub price and such amount was to be remitted each month to the Sealshipt Company.

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This carrier business flourished tremendously for several years until the present single shipment can was adopted, which is more sanitary and removes the necessity of keeping track of returnable carriers.

Next to the Presidency came the beloved Mr. Howard Beach who had the most difficult task of all his predecessors in keeping the Association together because of the Oyster Scare that broke out during his term. This was nationwide, and for many months no one struck a blow. Mr. Beach was instrumental in bringing about the Organization of the Shell Fisheries Commission of the various oyster producing states, and having them meet annually with our conventions. Another national advertising campaign was promulgated during his regime, and the Oyster Institute was founded. Through pronouncements by prominent governmental health officials brought about by Howard's intercession, confidence in the oyster was restored. Then later on, to add to his troubles, the nightmare of trying to adapt the conduct of the oyster business to the NRA monstrosity was foisted upon him and the Association. However, through the able assistance of Mr. Gordon Sweet in the North and Capt. Frank Darling and others in the South, the task was progressing rapidly, when the Supreme Court declared the act unconstitutional. But no one was reimbursed for the love's labor lost.

Besides these things, Howard induced Dr. Radcliffe, former Deputy Commissioner of Fisheries of the United States, to take the post of our Director - an accomplishment I believe every oysterman joyfully appreciates. Because of the Doctor's introducing the practice of sending out bulletins every few weeks, informing us of matters relevant to the oyster industry, we are kept up to date on improved methods of operation, impending legislation, what is going on in other sections, and everything that helps us to improve our own businesses and increase the influence of the Association. These bulletins also play an all important factor in cementing the Association between conventions, at which time we have the advantages of social and business contacts, together with the renewal of old friendships not only among the men but among the ladies also.

Howard Beach's untimely death was greatly lamented and brought into sharp focus all the benefits for which the Association and the oyster business, in general, were indebted to him. It would be no exaggeration to say that his passing was unduly precipitated by his devoted, unselfish, and conscientious efforts to better the Industry.

Now, in conclusion, a few words about our present incumbent, Jim Darling. I have attended practically all the conventions since the foundation of the Association, to wit Norfolk, Baltimore, Washington, D. C.,Old Point Comfort, New Haven, New York City, Atlantic City, Providence, Milford, Woods Hole, and Asbury Park. At some of these cities two and three and more conventions were held during this period.

At none of these conventions have we had a presiding officer more gracious and with as mellifluous a voice, as Jim Darling, to say nothing of his patience, his placating spirit, and his competence. With each convention he improves. As Mr. Killian carried us through the first World War with the aid of Jim's father as Vice President, so has Jim done the honors during the second World War with the aid of Dr. Radcliffe as Director and Paul Mercer as Vice President. In both cases has the cooperation of the members been engendered by the character and example of the presiding officers. Of course, with the change of the times and competiition of other food products at a cheaper price for the place in the stomach formerly occupied by oysters, the necessity for a strong Organization is more evident now than ever before. Purification of the waters to bring about greater production of oysters seems to be the most crying need to-day, and nothing less than a large, active, and virile Association can bring this about. May such an Association continue to live and function effectively and harmoniously for many many years to come.

THE OYSTER INSTITUTE ANNUAL REPORT

Lewis Radcliffe, Director

Chamberlin Hotel, Old Point Comfort, Virginia, June 7, 1949

We are gathered here to develop a program to check the downward trend of consumption of oysters, to increase production to a point that will enable us to sell our product at lower price levels and still make a reasonable profit, and to educate our people to the high nutritional values of oysters. We fully appreciate the fact that for over two thousand years oysters have been held in high esteem as one of the finest delicacies of the sea and we propose to maintain that reputation.

For the achievement of these ends, special emphasis needs to be placed on two objectives - the first and most immediate of these is to develop an educational program to include use of dealer helps, market research, the services of home economists and other aids which will assist us in focusing the eyes of the homemakers of the nation on the place of our product in the nation's diet. Gordon Sweet will lead in the discussion of this phase. Our second objective is to develop and apply the fruits of scientific research, particularly in the field of biology, to increase the supply of seed and market oysters and reduce the losses from oyster pests. Tomorrow morning Dr. Nelson will discuss this approach.

As American business is passing from a seller's market to a buyer's market, each of you must engage in a higher degree of salesmanship than you have had to exercise in more than a decade. It has been aptly stated that you 've got to start working on your feet instead of from your seat. Each of you has to maintain a reputation for marketing oysters of high quality while offering up a prayer that those who water their oysters will awaken to the evil of their ways and resolve to sin no more. You need to educate your buyers as to ways of maintaining high quality of your oysters even if you have to indulge in a bit of expense by supplying them with dealer helps in order to secure their cooperation. Better and more attractive packaging and better displays will prove to be helpful aids. Gordon will have a real message for you as to how to do this and Mr. James, Assistant Director of Fish and Wildlife Service, will discuss the many ways in which the Service can be of help. The next step will be to formulate a definite course of action and proceed to its accomplishment. Each of you should determine how much you can possibly do to lift us out of this era of decreasing demand and not only restore consumption to former levels but reach new goals. With the supplies of pork, beef, poultry, eggs, and canned goods increasing, with the prices of agricultural products falling off, and with the possibility of the Brannan plan to let agricultural staples seek their own level, your job of increasing the demand for oysters promises not to be an easy one, but it can be done. Let's will to do it.

Legislation and Related Matters

Wage-Hour Law - One of the greatest services ever rendered the fishing industry was the inclusion of Section 13(a)(5), the fishery exemption clause, in the wage-hour law, fathered by Congressman Bland. You are familiar with recent attempts to limit this to offshore operations. Fortunately for you, strong sentiment from all parts

of the country opposing any increased coverage of the Act by other groups as well as the fisheries has staved off change for the time being with the possibility that the only change in the law at this session will be to increase the minimum wage from 40 to 60 or 65 cents per hour. Those of you who opposed change in the fishery exemption are to be commended. As efforts to amend the section will undoubtedly continue, you may wish to formulate plans during this convention for greater participation with other groups to oppose increasing the coverage of the Act.

Consolidated Fisheries Case - Most of you will recall the many ways in which the Wage-Hour Administrator by arbitrary rulings has succeeded in limiting the coverage of the Act, by such rulings as refusing to grant exemptions to those engaged in the pearl button industry, also office help, watchmen, cooks, and the like in fishery plants. The ruling of the United States Court of Appeals for the Third District, made on March 31, 1949, in the case of a menhaden firm, Consolidated Fisheries of Lewes, Delaware, upholding the position that "all of its employees who are necessary to the carrying on of its fishery and fish processing activities are exempt by the plain language of Section 13(a)(5) of the Act" constituted a signal victory for the fisheries.

Fishery Exemption under the Motor Carriers Act of 1935 - Congressman Bland succeeded in writing into this Act an exemption in Section 203(b)(6) for motor vehicles used exclusively in carrying livestock, fish (including shellfish), etc. In the Monark Egg case first submitted to the Interstate Commerce Commission on April 27, 1942, the Commission ruled that fish as it came from the water, oysters in the shell, etc. were subject to the exemption, headed or eviscerated fish, shucked oysters, etc. were not. Without going into the lengthy hearings given this subject, in the Love case the U. S. Court of Appeals upheld the opinion of the District Court in Louisiana that beheading shrimp and freezing them did not remove them from the exemption. The first move of the Interstate Commerce Commission was to recognize the nation wide application of this decision insofar as it applied to shrimp. As a result of this action, shrimp may be transported by motor vehicles not licensed by the Interstate Commerce Commission if such vehicles are not used for carrying for compensation, any passengers or property other than exempt property as defined in the exemption. On April 11, 1949, the Interstate Commerce Commission reopened the case for further consideration as to its application to all fishery products. It is now anticipated that a final ruling will be made before mid-June and it appears we may receive a favorable decision. This would be another victory in restricting the activities of those who would read into law interpretations not warranted.

Canadian Embargo - The heavy increase in fishing vessels, shore plant facilities for packaging, freezing, and storing is creating a marketing problem, particularly for those nations which are able to consume only a minor share of their catch at home and must therefore seek export outlets. It is not surprising that they should look with envy on our markets as an outlet for these surpluses. With their low operational costs as compared with our own, they create a real problem for our fishermen whose costs of production are much higher.

Fortunately for our oyster industry, as the largest producer of oysters in the world, while our neighbors' production is wholly inadequate to meet their own domestic needs, we are in a favorable bargaining position. Immediately following our last year's convention at your direction I began negotiations through governmental channels to have the embargo lifted. In this effort, thanks are due our State Department, Canadian importers, fishery associations, and members of the trade for their splendid cooperation which resulted in the lifting of the embargo the first

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Fortunately for our [illegible] industry, [illegible] the largest producers [illegible] while [illegible] favorable [illegible]

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of the year. We would add a word of caution to those who for what appears to be selfish reasons are seeking to have the embargo restored September 1 to December 31. We hope that Canadian authorities will recognize their greater stake in the fishery trade with us and not jeopardize their own market needs. Let us not weaken our position by shipping into Canada poor quality oysters.

Canadian Tariffs on Oysters - As noted in a recent bulletin we were surprised at the wide variation in rates on imports of oysters into Canada. For example oysters fresh in cans of one gallon or more, the tariff is 5 cents per gallon, while for pints or less the duty is $2\frac{1}{2}$ cents, equivalent to 20 cents per gallon, and for quarts or two quarts $4\frac{1}{2}$ cents per quart, equivalent to 18 cents per gallon as compared with 5 cents for fresh stock. Obviously these rates militate against the use of individual consumer packages, and frozen stock, but the Canadian trade is seeking corrective measures. As previously stated we have only words of praise for the cooperation of the Fisheries Council of Canada and members of the trade in solving these problems. The relations between the respective health agencies have been marked by good will and an effort to amicably settle all matters up for consideration. Our packers of oysters can make an important contribution to this situation by exercising greater care in handling imports into Canada. Every shipment of oysters of poor quality can be used against you by Canadian packers who would like to have the embargo restored and incidentally will tend to discourage the consumption of our oysters in Canada. Therefore may I urge extra care in the preparation of your exports to Canada and thus build up the demand for our product among our neighbors consuming population.

The Hoover Commission Report

This report can be made the basis for important and far reaching changes in the present set up of the federal government with savings estimated at several billions of dollars. President Truman has strongly urged the Congress to grant him authority to put such changes into effect. Dean Acheson, Secretary of State, has taken the initiative in securing approval for the reorganization of his Department. It is reported that Secretary of Interior Krug is making his recommendations to the President to be used as the basis for legislation for the reorganization of his Department. The Natural Resources Committee under the capable chairmanship of former Governor Miller of Wyoming has made a magnificent contribution to the needs for grouping conservation agencies under a single Department of Natural Resources. The leaders in the fishing industry have an excellent opportunity for constructive effort by reaching an agreement as to the policy they desire adopted with respect to separation and location of the fisheries work of Fish and Wildlife Service. Sound policy would dictate that it belong in a Department of Natural Resources, but if there is to be bickering and lack of initiative among the various conservation units, then it might be preferable to seek to have fisheries work transferred to the Department of Commerce. I am deeply appreciative of the efforts of those members of the industry who aided in having me appointed Consultant to the Natural Resources Committee.

Need for a Definite Fisheries Policy

As long as the leaders in the fishing industry remain without a definite policy as to whether a Fisheries Branch separate from Wildlife should be established and in what department of government it should be located, we shall be like a vessel without a rudder. As long as the fishery associations sponsor legislation for the sake of expediency without agreement among the loading associations or even without the general support of the membership of each we shall remain weak. Every time a

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rider covering the work of the Fisheries Division is introduced into an appropriation bill for the conduct of work by some other department which properly belongs to the Fisheries Division, we are confusing members of Congress when we should be educating them to think of the Fisheries Division whenever they think of a fisheries problem. Whenever any such measures of expediency is proposed, every member of the industry should oppose it. If you think little of the work of the Fisheries Division, you can't escape blame in part, for each of us should contribute all possible aid to making its work effective. Let us remain united on this subject.

Mechanization of the Industry

Commendable progress is being made in the mechanical handling of oysters by dredging, unloading, etc. There have been improvements in the regular dredge to increase its effectiveness. Of greater importance are the developments represented by hydraulic dredges developed by Flower, Nelson, Sweet, and Bailey, and the harvester type of Brown and Jurisich. These provide means of dredging oysters or the enemies of oysters on a scale hitherto undreamed of and should contribute materially in reducing the cost of production.

One important field with great labor-saving potentialities has scarcely been touched - the mechanical shucking of oysters. More labor is employed in this operation than in any other branch of the industry. Shucking costs have risen within your memory from 15 to 20 cents per gallon to 85 cents to 1 dollar or more per gallon. Under proposed wage-hour legislation you are confronted with proposals that can wreck the industry.

A cost of production survey made by W.P.A. for Maryland oysters in 1936 showed that shucking labor represented 25 per cent of the cost of production. The shucking of oysters is not a type of work to attract labor. It requires special skills not easily mastered by some workers. As time passes we may expect it to become less attractive and your difficulties in obtaining the necessary labor may be expected to increase. It appears obvious that efforts should be made to overcome these difficulties by perfecting mechanical means for doing this. How shall we proceed to attain this objective? Is it a proper function of your Washington office to try to aid in this accomplishment? These are questions to which I would appreciate your giving consideration and advice.

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Your Washington office personnel has had one of the most trying years of memory. Efforts to keep the work current have necessitated your Director putting in a 7-day week much of the time. Through the Institute bulletins you have been kept acquainted with current matters affecting your business. You have received 12 trade reports containing valuable information on a variety of subjects. An unusually large number of bills affecting the fisheries have been introduced into Congress. We have endeavored to keep you fully informed on the progress of those up for hearings and placed before the Congress for action. Our relations with the Fish and Wildlife, the Food and Drug Administration, the U. S. Public Health Service, and other executive branches of the Government have been most pleasant. Requests from feature writers for printed matter and photographs have received particular attention with the result that a number of articles publicising oysters have appeared in print and your Washington office commended for the excellence of the material supplied. Our relations with other trade associations have been pleasant and helpful. With

three of the leading fishery associations with headquarters in Washington, the interests of the fishing industry are being better cared for than ever before in our history. The leading fishery journals have greatly improved during the past decade by their increased coverage of scientific and trade developments and space devoted to Washington events.

One of the most gratifying features of the year's work is your loyalty and faith in our program as evidenced by the promptness with which you have paid your dues, the amount of outstanding dues being the lowest of record, and also by the greater use many of you are making of our services. I have never understood why so many of our members, particularly those in the lower due brackets fail to bring their problems to us especially as we consider this to be one of our most important function and welcome all such requests. Incidentally another bright spot is the volume of helpful correspondence with buyers of oysters at home and abroad. We have encouraged such correspondence with the result that we receive much helpful material recounting their experiences and receive many requests for information on a variety of subjects. These are a few of the many ways in which we have tried to serve you, but I will not burden you with further details at this time.

Reference should be made to those who have passed to the beyond. Among these was Joseph N. Fowler, who died on October 4, 1948, at the age of 70, who served the oyster industry of his native state, New Jersey, in many ways. Also Charles E. Wheeler, who died on March 19 of this year at the age of 79. "Shang" as he was generally called, for many years was one of the most colorful figures in the oyster industry.

There are not a few visitors at this convention who if they were made acquainted with the work of the Institute would undoubtedly appreciate the importance of membership in the Institute family. I hope regular members will make their acquaintance and explain the need for wider representation from all oyster producing areas.

And finally I wish to thank our officers, directors, and members of the Association and the Institute for your loyalty and efforts to make a success of our program. Your letters of commendation and, yes, those containing constructive criticisms are always welcome in your Washington office. You are urged to make greater use of the services offered. By so doing you materially aid in making us acquainted with your problems which are usually shared in by others.

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WE CAN GET OUR SHARE

Digest of Address of H. Gordon Sweet

Convention at Chamberlin Hotel, Old Point Comfort, Virginia, June 7, 1949

1. The change from a seller's to a buyer's market poses critical problems.

2. We must not expect the Government to solve these, for they will not do so.

3. The remedy lies largely within the industry and above all, in the intelligence, foresight, and courage of the individual members.

4. The first requirement is to demand of ourselves the highest possible standards in the quality of the oysters we offer to the public. This means protecting the consumer in the greatest possible enjoyment of our product. ONLY in this way can we deserve and get our share of the food dollar.

5. We must each make a detailed study of our business operations for the year ahead, including a target figure for the gallons and bushels we propose to turn out, together with all items of cost, direct, operating and overhead. This will involve certain assumptions, some guesswork and so forth, but much of the essential data is available. This gives us the price we should get for our output.

6. With this price always in mind, and realizing that the determination of each one of us is what gives "tone" to the market price, we must confront the buyer of oysters. Out of this pressure results the actual prices at which oysters of different localities, sizes and characteristics will change hands.

7. If, in selling, we take the line of least resistance and solve every problem by reducing the price, we shall bring on a panic which will put every one of us in the red. Our costs will remain high and the supply is, for the country, limited. There is no reason why we may not ask and receive a cost price for our 1949-1950 output. THERE IS NO GLUT HANGING OVER US.

8. The budget suggested above will change from month to month but is of value if the figures are adjusted in the light of current developments.

9. The buyer is not anxious to pay a fair price for your merchandise unless you, collectively and individually, compel him to do so.

10. The consumer, the retailer, jobber and wholesaler WILL take our oysters IF we produce, pack, and ship a product which we as lovers of good food serve with pride on our own dinner table and offer with satisfaction to our friends.

11. The Oyster Institute can, for a limited sum, engage the services of public relations counsel to publicize every newsworthy aspect of the oyster industry, to the end that our product will be continually brought to the attention of the public. I believe there is a tremendous opportunity here which has never been fully explored.

12. Oysters are an impulse food. They are ONLY consumed when the restaurant has them ready and listed on the menu, when the retailer has them in his store ready for the housewife. But even then, they are not consumed until the restaurant patron orders and eats them, until the housewife buys them, takes them home, cooks, and serves them on the table.

13. Therefor, in addition to seeking national publicity for oysters so that the word OYSTER will recur in a newsworthy context as many times during the season as possible, the Oyster Institute should provide certain Selling Aids at point of sale, to give the restaurant patron and the housewife at the market or grocery, the impulse to buy, at the place and time where sale and consumption result.

14. The decision of how to do this should rest with experts, subject to the approval of the Institute Directors.

15. The public relations work should be done for one year at the expense of the Institute. After that, the work should be evaluated and continued or not, depending on results obtained and demonstrated. After the first year, the expense should be covered by the Industry, not the Institute.

16. The Selling Aids should be devised by experts to sell OYSTERS at the point of sale. They should be procured by the Institute and sold to members at cost, for distribution through their regular trade channels. It will take a good selling job to move these promotional items, get them purchased by members and used. They will not sell themselves, no matter how good. This is a job the Institute can and should do.

17. Conclusion: We can get our share of the business IF:
We pack a fine product and get it to the consumer in perfect condition, and if
We work out a clear figure for the price each one of us must get for his output, and if
We make a determined effort to get this price in the face of buyer resistance, and if
We stimulate demand through nationwide publicity, and if
We provide material at the point of sale that OYSTERS are for sale.

18. Food prices are trending down because of abundant supply. However, the volume of retail trade is high, people buy what they want within reasonable limits, and the supply of oysters is not so great but what there will be a healthy demand for the Industry's output in the season ahead.

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The Oyster Institute of North America

POINT OF SALE MERCHANDISING

Malcolm A. Thompson, Eastern Sales Manager
H. L. Peace Publications, "Southern Fisherman"

Convention at Chamberlin Hotel, Old Point Comfort, Virginia, June 7, 1949

Point of Sale Merchandising isn't designed to confuse or mystify. It adds up to two things ... sales and profits, both vitally important to any business. And, it can be applied to the shellfish industry.

Point of sale merchandising, like charity begins at home ... at the point of production. Right here at home where shellfish are produced is where any sales program is started. Poor or inferior merchandise automatically precludes any successful sales program.

Specifically, point of sale merchandising or advertising is that certain something that stimulates a latent desire for merchandise on the part of the consumer. Within every shopper or consumer ... nine times out of ten a woman... there is a subconscious urge to buy. This same woman buys about 90 per cent of the ties we men wear and an equal percentage of all foods. Merchandising at the point where she makes her purchase stimulates an impulse to BUY.

Many times I've heard an oysterman say: "If only I could reach the consumer." The same oysterman readily admits that good trade journals materially help move produce to the wholesaler. "But," he asks, "how can I reach the consumer?" This is a good question and frankly, gentlemen, one that is not easily answered. There is, however, one solution that could come close to solving the whole problem.

Yes, I refer to "Point of Sale Merchandising" ... that point of purchase where the impulse to buy is stimulated and the final purchase is made.

Val Bauman, sales manager of the National Tea Company, establishes three steps in merchandising any product. They are: (1) Production, (2) Distribution, and (3) Point of Sale.

Both production and distribution ... distribution in the sense of a movement of goods from plant to wholesaler ... are problems which are rapidly being solved.

The point of sale to the consumer is a more pressing problem and one which I hope to help alleviate.

Mr. Bauman explains that the National Tea Company classifies all advertising used in one market as "point of sale" advertising. Newspaper and radio advertising are included in this classification along with posters, counter displays and other material used in the store.

I prefer, in consideration of certain limitations imposed on the shellfish industry, to discount for all practical purposes newspaper, radio, and magazine advertising. Because of many individual marketing and production problems it is,

as I see it, virtually impossible to subscribe funds sufficiently large to undertake a comprehensive national consumer advertising program via radio, newspaper, or magazine. The National Fisheries Institute has met with only limited success so far as building any substantial and lasting advertising program is concerned. The Institute is being beaten by a lack of money.

The American Meat Institute will spend more than two and a half million dollars for advertising in 1949. And, whether we like it or not ... a leg of lamb or a roast of pork is meat whether it comes from Texas or New York. On the other hand a pint of oysters from Maryland or Virginia is not the same ... so far as your customers are concerned ... as a pint of oysters from Long Island, New Jersey, or Connecticut. The record you heard, although made in fun, indicates a keen rivalry among our oyster producing areas ... a difference of opinion that must be considered.

Just as there is a difference in package tastes so is there a difference in sales methods. One firm may work entirely thru restaurant suppliers ... another thru wholesalers or brokers. It is right that each individual in the seafood industry should play an active part in any advertising program no matter how big or how small he may be ... and regardless of his method of operation.

Point of Sale Merchandising can give the individual an opportunity to express himself and to institute a program directly in line with the money he wants to spend and can spend. If XYZ firm in Long Island has only 50 customers he won't want to spend the same amount of money for advertising as a firm with 300 customers.

A program such as I am suggesting takes into consideration some of the pitfalls that have confronted attempts by the seafood industry to build a successful advertising program. I am suggesting it in the interests of harmony and greater benefits for everyone concerned. A point of sale campaign is designed to give every packer of shellfish a proportionale share of responsibility. There can be no taxation without representation: everyone must benefit in direct proportion to how much he can spend.

There seems to be no available statistics on shellfish in relationship to buying habits. "Chain Store Age" devotes 60 pages to meat, fish, and poultry in its November 1948 issue. Of this total of 60 pages ... less than half a page is devoted to shellfish. Why? Probably because this was all the information that was available. A point of sale advertising program could very easily make the food industry aware of the undeniable fact that shellfish IS a major factor in the American food plan.

The POINT OF PURCHASE INSTITUTE, in New York, however, provided me with information on the use of point of sale material. Their survey of 150 national advertisers clearly indicates that more than 85% of the material supplied to grocers is used to sell more merchandise at higher profits.

I browsed thru the New York public library long enough to dig up some interesting information. The Department of Commerce shows that fish and shellfish ARE included among a retailer's high profit items. Fish, shellfish, vegetables, meats, and dairy products are listed as the top five.

Retailers will, therefore, work with you thru a point of sale program because they know there is a profit ... and a relatively high one ... to be made thru the sale of shellfish.

In an intensive survey conducted recently in Syracuse and Rochester using carefully controlled test stores, the "Point of Purchase Institute" proved that stores using point of sale material showed an increase of from 20 to 113 per cent on those items utilizing the material. There was a marked increase in sales over those stores not using point of sale material.

We must have faith, therefore, in the power of advertising at the point of sale ... the place where the consumer makes her decision to BUY. It isn't difficult to recognize that the consumer, in about 75 out of 100 times, makes up her mind only when she is in the store. She is governed by eye appeal ... pack, neatness of pack, and whether or not the last XYZ package was good or bad. If it was bad then no amount of advertising will induce her to repeat her original purchase. The pack must be good. If it is ... point of sale material will give you a steady, well paying customer.

Assuming that the pack is good ... what next? What about brand packing?

Beyond a shadow of a doubt the consumer is governed in her purchases by brands. This fact should be a foregone conclusion. A branded pack seems to give her confidence in the product and speaks her language of purchasing. However, again we must admit our limitations. We cannot make shellfish products as nationally brand famous as Heinz Soup or Cambells Beans. We must, then do the next best thing. We must, when humanly possible, make shellfish packs so attractive that they spell one word to the consumer ... quality.

Branded packs help sell merchandise. If you're selling in gallon lots, then provision can be made for the retailer to repack with your branded label ... or branded container. The pickle barrel and the cracker box have gone with the horse and buggy. Still, in many stores, the retailer ladels out your carefully packed oysters in a wooden spoon and doles them out to the customer in blank, white paper containers.

How can you as wholesalers and producers carry your brand right thru to the consumer? It isn't going to be an easy task to whip horse and buggy methods. But nothing is easy until you start doing it. You can make it possible for the retailer to use a waxed paper container with your label on it. The manufacturer of these containers will work with you. He will print a branded container for your distributors ... or he will work with you in preparing labels for the distributor to stick on every container he sells. Believe me, gentlemen, Mrs. Consumer likes to repeat her purchases. She would much rather ask for "Southern Fisherman" brand oysters ... than just plain oysters.

The Sealright Company,of Fulton, New York, has been cooperative in helping with display material. Although not new in other industries, the counter display with place for a container -- in this case a Sealright "ThermoKing" waxed paper container -- is a new idea for the shellfish industry. It's an idea that can sell more of your products at increased profits. It indicates the possibilities of this type of seafood container for repacking by the retailer. He can and, I believe, will repack in your branded container if given the incentive.

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This is point of sale merchandising via the wholesaler and the retailer. Whatever you do to make it easier for the wholesaler and the retailer to sell MORE produce at greater profit will surely help you build sales and profits. It is as inevitable as night and day.

Now ... another question. Should a point of sale program be designed to push individual brands. The answer, I think, should be NO. What benefits the shellfish industry as a whole benefits the individual. It is impossible to build a national brand advertising campaign. Shellfish, then, should be sold under one banner ... the Oyster Institute of North America, an old and respected name in the annals of American business. Individuals can benefit by using their own brands, but advertising should be designed to do one thing ... sell more shellfish.

An attractive series of point of impulse material (display) will boost the sales of shellfish. There is an equal opportunity for small and large packers. A point of sale program is designed for the individual. Provision can easily be made without increasing costs to permit an individual packer to establish his brand at the point of sale. Here again is the opportunity expressed earlier for the small packer.

I have with me a number of sample "point-of-sale" displays created by Palmer Associates of New York. One, the shapely and beautiful girl you see, may be a little too expensive for some packers. But, believe me, she would make a mighty attractive window or floor display for some retail store or restaurant ... and she'd help sell more shellfish in the bargain.

I hope you'll appreciate these sales promotion displays ... not for the work involved in making them ... but for the opportunities presented by the use of them ...

Oysters have been sold since time immemorial. The Romans, Anthony and Cleopatra included, ate them with great gusto, served with lemon and red pepper. Lord Byron refers to them as an "amatory food," and Dr. Samuel Johnson prescribed them as a sure-cure for most anything. And Shakespeare writes in the "Merry Wives of Windsor," "Why not then, the world's mine oyster which I with sword will open." An ode published in 1806 referring to Lord Nelson's conquest of the seas refers to oysters in rhyme: "Nelson has made the Seas Our Own. Then Gulp Your Well Fed Oysters Down ... And give the French the Shell."

The mid 1800's were banner oyster years in this country. A group of Baltimore packers started the first national advertising program. A wagon train run was established between Baltimore and Pittsburgh long before the Baltimore & Ohio came into being. The Union Oyster Company was formed in Baltimore in 1878 to combat unfair trade practices ... namely to prevent watering of oysters in, yes, unlabeled cans. And, in 1865 and thereafter special trains of from 30 to 40 cars moved daily from Baltimore as far west as Detroit. In 1856 Levi Rowe & Company in Fair Haven, Connecticut, operated 20 vessels in filling their orders; employed 100 shuckers; sold about 150,000 gallons of oysters yearly as far west as Chicago. Rowe & Company in the roaring 80's used as many as 150,000 kegs in a single year at a purchase cost of $15,000.

A federal government book printed in the 1800's, commenting on advertising and oysters quotes: "Packers of New Haven became equally well known along the Chesapeake, and, through wide advertisements, over the whole country. (From the "History and Present Condition of the Fishery Industry" by Ernest Ingersoll.)

So, you see, gentlemen ... advertising of shellfish isn't new. If the truth be know chances are that oysters were among the first of this nation's products to be nationally advertised.

Believe it or not ... advertising need not be expensive to be effective. A national program in the usual run of consumer magazines, newspapers, and radio programs is out of the question. There just isn't the money. The next, and I suggest the ONLY alternative is something relatively inexpensive that will reach the consumer at the point of purchase. This next best thing ... and it's really a good thing ... is POINT OF PURCHASE MERCHANDISING.

I'm willing to bet a Long Island oyster against a Chesapeake oyster that there isn't one of you here who doesn't find some stimulation just by looking at these displays. Believe me, gentlemen, if used by the shellfish industry, they WILL stimulate an urge to buy more oysters, crabs, clams, and shrimp. They can boost your sales to a new high.

By utilizing ... new methods of seafood transportation such as the Church Container ... new packaging methods (the paper container) ... and point of display material for your retailers ... you can help to build a better shellfish industry at least so far as sales are concerned.

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Gentlemen, I've known most of you for quite a few years. I feel that as an outsider with an insider's view that I can appreciate some of your problems. I know there are limitations to what you can and will do. Believe me, I've spoken with the utmost sincerity hoping that you will give some very serious consideration to point-of-sale merchandising. It can do all of you a whole lot of good and seems to me an excellent way to sell more shellfish.

In closing I'd like to quote from an organization that knows the answer. The "Point of Purchasing Institute" of New York says:

> "POPeye" will sell more of your products, too. Whether you sell cosmetics, blowfish, oysters, coal, or rugs, well-planned point-of-sale material will sell MORE of your product. Regardless of the type ... window or counter displays, wire hangers or wall cards ... POPeye is a volume booster that no sales or advertising plan can afford to omit. For special tests or continuous use ... in ten stores or ten thousand, plan on important sales gains with important point-of-display advertising and merchandising."

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ADDED NOTES: STATISTICS ON "POINT OF SALE MERCHANDISING"

W. P. Lillard, Sales Promotion Manager, General Foods: "Three-fourths of all women shop from memory without written lists, and about two thirds of all purchases are made on impulse." General Foods spent about $1,000,000 in 1948 on point-of-sale material.

Survey by DuPont Based on Interviews with 1778 Shoppers in Seven Cities from Atlanta, Ga., to San Francisco - Proved conclusively that 66 per cent of the "impulse bought" items were on display.

Survey by Point of Purchase Institute - A recent survey of 150 national advertisers indicated that grocery stores throughout the country utilize more than 85 per cent of the point-of-sale merchandise supplied them.

Another Survey - Of 1448 shoppers at service grocery stores showed candy leading the list of unplanned or "impulse"purchases ... followed by fish and shellfish.

Another Survey - By a business group shows that 75 per cent of shoppers buy at least one item which they had not planned to buy and that more than 25 per cent of all items are bought on impulse at the point of display ... or sale.

Survey By Progressive Grocer (Magazine) - Of 1247 independent merchants shows that 65 per cent of these merchants will use more displays; 2 per cent will use fewer; and 33 per cent will use the same.

Direct Inquiries to Mailing Piece Offering Displays to Watch (Jewelers) - In response to about 10,000 inquiries ... more than 3600 jewelers wrote in and requested point-of-sale material for their stores.

From "Tell" Magazine - "One prewar survey showed that 75 per cent of food store shoppers bought, on impulse, at least one item they had not intended to buy. The number of impulse sales in these outlets totaled 24.6 per cent. An identical postwar checkup showed sales to be up 50 per cent, so that unplanned purchases account for 33.8 per cent of all food items.

New Rochester-Syracuse tests again prove that "point of purchase" produces immediate important (20% to 113%) sales gains.

No other medium can measure efficiency this way. How much a display sells, not how many see it, was the basis of tests conducted by Fact Finders Associates for the Point of Purchasing Institute. Leaping sales of eight nationally advertised products proved the immediate sales power of window displays. In this two city test of comparable yet not overlapping markets, 160 stores indisputably proved substantial gains in sales where displays were used, and surprising drops in sales of identical and competitive items in most test stores without displays.

After the test period was over ... there was a "hangover" period of effectivness after displays were removed when stores showed gains in sales up to 76 per cent.

Cost Factor - In cities of 250,000 and more population, a window display cost per 1000 consumers is estimated at 50 cents. Costs increase up to $1.00 a thousand in cities of less than 25,000 population.

WHAT FISH AND WILDLIFE SERVICE IS DOING TO INCREASE PRODUCTION AND CONSUMPTION OF OYSTERS

Milton C. James, Assistant Director, Fish and Wildlife Service

Chamberlin Hotel, Old Point Comfort, Virginia, June 7, 1949

At your 1946 Convention, with the bloom still on my commission as Assistant Director, I appeared before you with a slight feeling of trepidation since, outside of the salmon packers, your's was the first important fishery trade group which I had faced. I already knew what kind of punch the salmon packers packed, but you were an unknown quantity. At that time I could seek your indulgence on the basis of lack of time to familiarize myself with your problems. I can no longer fall back on this cushion, if I wanted to, which I don't.

In 1946 I was forced to indulge in some doleful comments with respect to the possible curtailment of certain Fish and Wildlife Service functions as an outcome of some very sharp pruning applied to our appropriations by the Congress. The severity of these cuts was lessened somewhat, later on, and those curtailments which were obligatory were applied elsewhere than in the shellfish studies. Today I think I can note in the present Congress a distinctly different attitude which seems to point to a genuine recognition of the significance of the fisheries as a whole, and to acceptance of the Government's responsibilities to the fisheries.

The Hoover Commission Report, starting with its original Natural Resources Task Force recommendation and carrying through to its final reports, repeatedly pointed out the importance of improving and even expanding the Government's services to the fishing industry. I can assure you that, in contrast, the Hoover Commission Report was very conservative in supporting any expansions of other Government services in general. While there are differences of opinion as to some of the conclusions reached by the Commission with respect to matters of organization, there can be no quarrel with the basic policy with reference to the fisheries as reiterated in the Commission reports. All this has an encouraging sound. It is no secret that your spokesman, Dr. Radcliffe, can properly be credited with some of the responsibility for this state of affairs.

I am scheduled to speak upon the functions and activities of the Fish and Wildlife Service as they pertain to the oyster industry. These studies and activities are not wholly satisfactory to the oyster industry, to officials of the Service, or to the Fish and Wildlife Service staff engaged in the activities. This sounds like a splintered, cracked springboard from which to dive into a discussion, but it is a purely natural, normal manifestation of the complications of getting Government and industry together on details.

In using the term "not wholly satisfactory" I do not want to concede that the program as a whole is materially deficient. I simply want to recognize the fact that it is not ideal - particularly as to extent of coverage. I know that various segments of the industry believe that greater emphasis should be placed on certain local problems. I know that members of our staff are eager to embark on many new studies and activities, feeling that with more adequate funds they could chalk up

accomplishments of vastly increased value. Finally, as an official of the Service I must admit that the constant effort to balance off our funds and resources in meeting the constantly increasing demands from all segments of the fishing industry leaves us with a feeling of frustration and a sense that first things have not always been placed first.

Thus the program on which the Fish and Wildlife Service is now engaged in behalf of the oyster industry is a compromise, as are the major part of the activities of any Government agency. With this preface, which is not an apology, but rather an X-ray of what is behind or within, I am glad to enumerate the highlights of the Fish and Wildlife Service functions of interest to the oyster industry.

First, there is the provision of statistics which is the life blood of any industrial enterprise. The collection of statistical data on the oyster industry is of course merged into a much broader program of collecting and tabulating figures. I think we are in position to achieve some broader coverage in this field in the succeeding year, particularly with respect to the southern areas. There is nothing spectacular about this, and I would like to dismiss it with a comment that we look upon the statistical work as fundamental to any appraisal of any of the specialized fisheries. Your comments and recommendations as to improvements in this field will always be welcome.

The Service has been somewhat more active in the last several years in connection with the marketing and merchandising of your product. Among these activities, which we hope have gotten some results, and which may be of interest to the industry, has been the matter of the containers utilized in marketing oysters. Effort has been made to promote on the East Coast the use of glass jars in place of pasteboard cartons, which is really the transplanting of a West Coast idea to the East. We have also been plugging the use of pliofilm bags for packing oysters in their own liquor, since it was felt that such a method of merchandising would be particularly advantageous in the swiftly developing field of self-service merchandising. I am sure you will recognize the advantages in this method, including the attractiveness of the package, the readiness with which the consumers can see what they are buying, and the flexibility in container sizes to meet varying purchaser needs. There is indication that this method of packaging is taking hold. Also, on the merchandising side we have been advocating, through Market Development Bulletins and by personal contact, the dating of shucked oysters handled at retail outlets. Several firms, notably a large chain store in the mid-West, are reported as adopting this modern method of handling a perishable product. We are trying to stimulate other progressive marketing practices, such as the preservation of oysters by freezing as a means of levelling out peaks and valleys in the supply situation. Maybe the Market Development activity in which we can take the most pride is the fact that we have kept Mrs. Rose Kerr, of "How to Cook Oysters" fame, and her capable staff on the job. I expect Mrs. Kerr to present to you in person an outline of what she is doing and the hows and whys of her program. It would be an imposition for me to give a second-hand recital of what she can so competently explain herself, and I am yielding this part of my discussion to her. It should be said that the Service greatly appreciates the advice and suggestions of Dr. Radcliffe which were forthcoming at a meeting a number of months ago when the Service undertook to overhaul its Market Development program in line with the suggestions and comments of various representatives of the fishing industry.

When it comes to outlining the Service's program of biological research I shall eliminate reference to the newly inaugurated program of clam investigations. Clams have staked out their legitimate claims to be called shellfish, and I see many individuals in the audience whose interests encompass all shellfish, but I recognize that primarily this is a gathering of oystermen. Briefly the objectives of the oyster research are to acquire information on the physiology, propagation, growth and fattening of the oyster, on environmental conditions required for the optimum propagation and growth, on experimental cultivation, and on protection against natural enemies and parasites. This information can be used by the industry itself as a basis for improvement of its production techniques, or can be utilized by Federal and State agencies in formulating laws and regulations pertaining to the conservation and management of the resource, the harvesting of the crop, and the sale of the product. It hardly seems necessary to say that regulations will be sounder and saner to the extent that they are based upon hard facts and precise knowledge.

Running quickly over the work-sheet I would like to mention that in cooperation with the Maryland Department of Tidewater Fisheries a long-term study of factors controlling the yield and quality of oysters, and the evaluation of Chesapeake Bay oyster grounds, is based at Annapolis, Maryland. For the purpose of developing a practical system of shell planting by studying factors controlling the time and intensity of setting, studies are under way at Pensacola, Florida, Milford, Connecticut, and Annapolis, with cooperation by various State agencies. The same laboratories are also devoting attention to the effects of salinity, temperature, turbidity and other factors on spawning, setting and survival. Complicated studies on the physiology of oysters are centered at College Park, Maryland. The theory back of all this is the belief that the more we know about what makes an oyster tick, the better able the industry will be to make oyster production a planned operation, rather than a matter of chance. The ever present question of enemies, predators and parasites is under review at all of the shellfish centers, including Milford, Woods Hole, College Park, and Pensacola.

This is a grimly technical review and it might be well to humanize the explanation a little. I think the Chesapeake Bay studies can be cited as an outstanding example of joint Federal-State cooperation with the long-term objective of improving oyster conditions on all of the oyster bars in Maryland waters. This program does not necessarily stop at the Maryland boundary, but looks upon the Chesapeake Bay as an entity. Probably the principal contribution has been the provision of general technical services of a high order of competence in an area where oyster production has for a long time been undergoing serious vicissitudes.

Efforts to produce seed oysters of good quality in sufficient abundance in the Chesapeake Bay have been just one facet of this undertaking. I was greatly gratified to receive within the last month, from Maryland State officials, several unsolicited expressions of commendation of the Fish and Wildlife Service staff engaged on this program. Marylanders know what they need and want, and it is pleasing to feel that they think they are getting it.

In Long Island Sound the biological approach to the promotion of oyster production has been somewhat different. There one of the principal enemies of the oyster is the starfish, and one of the principal biological deterents to a healthy condition for the industry has been the enormous and violent fluctuations in the success of setting. Here Service biologists have been maintaining a close check on the presence, migration and abundance of starfish so that control methods developed by the Service or by others may be put into effect as the need arises and at the

proper time. The industry also has been kept informed currently of the degree of the maturity of the oysters, the water temperature regime and the presence and abundance of oyster larvae in the water in order that oystermen may put out cultch for the collection of spat.

Oysters in the Gulf of Mexico always have seemed to offer tougher biological problems than elsewhere because of a series of natural hazards of the hurricane belt, and almost inexplicable and sudden mass mortalities on the beds. I say inexplicable because, although many theories on causes have been offered, any one of which might sound reasonable at the time, there really seems to be a complexity of causes, or at least a great many different causes for this mortality in different places. During the past two years there has been an unusual group of scientists engaged in really basic studies of oyster biology and ecology in the Gulf. I refer to the large group working in the Service's marine laboratory near Pensacola, Florida. There are two agencies represented besides the Fish and Wildlife Service, and from all I have been able to learn these eight or nine biologists and technicians have worked harmoniously and productively in an isolated situation where scientific temperaments might be expected to clash. I cannot speak for the work of the other agencies, but so far as the Service is concerned we are hoping to continue and even to expand our work on the Gulf. We have made some preparations toward that end through an informal agreement with the State of Florida, which will make possible a test in a large and formerly productive oyster growing area near Pensacola, to determine whether such an area may be restored to production and continue as an economically and biologically sound proposition.

This general outline depicts a group of continuing projects which interlock rather closely, although retaining identity of purpose and scope. There is nothing sacred about any feature of this program. Changes can be made. However, if changes and shifts are to be undertaken, it should be done on the basis of sound and logical reasons with due weighing of pros and cons.

One of the great weaknesses of American fisheries research in general is that much of it has been directed toward meeting sudden drastic crises and emergencies. To put it another way, we have been trying too often to diagnose and treat illnesses without actually knowing how to recognize a state of good health. That's why I want to offer this word of caution against unwarranted changes in either State or Federal programs of shellfish research.

In closing I want to pay tribute to the Fish and Wildlife Service staff members who are carrying on this program. If it proves valuable and effective the credit is theirs. The quality and caliber of biological research, technological studies, and Market Development activities are determined by the people who are actually on the job. However, if it turns out to be ineffective the desk-bound officials - but on second thought I'll not even finish this sentence. Anyway, a goodly number of our staff are here. I hope you will take this opportunity to meet them, discuss your problems with them, and offer freely your comments, ideas, suggestions and recommendations. Although my stay at this convention will be short, that goes for me also.

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HOW TO INCREASE CONSUMPTION OF OYSTERS

Mrs. Rose G. Kerr, Home Economist, Fish and Wildlife Service

Chamberlin Hotel, Old Point Comfort, Virginia, June 7, 1949

It is a pleasure to be here at your annual convention. Mr. James, our director, has just told you "What the Fish and Wildlife Service is Doing to Increase the Production and Consumption of Oysters." Dr. Radcliffe asked me to tell you a little more in detail what the Home Economics unit of the Service is doing since it ties in with your industry-wide promotion campaign.

How to increase the consumption of oysters and shellfish is something that is almost constantly uppermost in the minds of most of us connected with the fishing industry regardless of whether we have a hand in actually hauling the catch aboard ship or merely play a related part in getting it to the ultimate consumer. How to make the public aware that there are such things as oysters and shellfish, that they are plentiful, nutritious, relatively easy on the family's pocketbook, and are delicious when properly prepared; these are just a few of the things that come under the heading of fishery education.

And what part have the Home Economists of the U. S. Fish and Wildlife Service played in this picture? During the last three years since the formation of the Home Economics Unit as a part of the Branch of Commercial Fisheries, we have given 191 seafood cookery demonstrations for approximately 12,500 persons in 22 states; conducted 13 exhibits for approximately 80,000 prospective consumers representing every state in the Union; distributed approximately 75,000 fishery publications; cooperated in the filming of HOME COOKERY OF FISH; and issued cookery bulletins entitled FISH COOKERY FOR ONE HUNDRED, BASIC FISH COOKERY, and HOW TO COOK OYSTERS.

At the inception of our program of exhibits the question naturally arose as to where they would prove the most effective taking into consideration the limited funds available. National conventions, particularly those whose members are responsible in some way for the serving of food, appeared to be one solution. As a result, thirteen exhibits to date have been conducted at the following conventions: American Home Economics Association Convention - Cleveland, St. Louis, Minneapolis; National School Cafeteria Association - Chicago, Dallas, Baltimore; National Restaurant Association - Cleveland, Atlantic City, Washington; American Dietetics Association - Boston; National Fisheries Institute - Chicago.

As previously mentioned, approximately 80,000 consumers and potential consumers have viewed these exhibits. About 8,000 of these have indicated further interest by sending in written requests for additional information.

In preparing these exhibits, it was felt that as wide a variety of species and market forms of shellfish and fish as possible would have more appeal and be of great educational value. Therefore, the following species were usually displayed:

Lobsters, scallops, and fillets from New England
Oysters, crabs, and clams from the Middle Atlantic
Shrimp and frog legs from the Gulf
Salmon and halibut from the Pacific
Seasonal lake fish from the Great Lakes

Each species in turn was shown in its various market forms. Shellfish, such as oyster clams, and scallops were displayed in the shell and shucked; shrimp was shown in the four forms from raw to ready-to-eat; lobsters and crabs were displayed alive and cooked. Besides the fresh fishery products display, a representative group of canned and frozen fishery products were usually shown.

It should be noted that in carrying out these exhibits, splendid cooperation has been given us by the fishing industry who contributed generously of their time and supplied the seafood for the displays.

Several things are of interest in regard to these exhibits. Foremost is the fact that the display of fresh fish and shellfish attracted the greatest attention. Many of the foods teachers and cafeteria managers had never seen a scallop, had no idea where they come from and were somewhat skeptical that they were shellfish. Anothe thing was the genuine interest in seafood shown by most of the visitors and the marked desire to know how to prepare and serve it. This was borne out by the written requests of 7,975 persons for additional information. Approximately 75,000 Fish and Wildlife Service publications have been required to answer these requests and those emanating from the fish cookery demonstration.

In regard to the 191 seafood cookery demonstrations,which have been given for 12,500 persons in 22 states, it is agreed that the number of people contacted is smaller than at the exhibits; however, it must be remembered that most of those 12,500 persons are directly responsible in some manner for serving food to others who in turn have thus been indirectly influenced by the demonstrations. The demonstrations were given before the following groups:

Women's organizations and university and college food classes ..	93 demonstrations
School lunchroom managers and cooks	86 demonstrations
National and state restaurant association meetings	7 demonstrations
The U. S. Army Subsistence School	5 demonstrations

What is meant by a demonstration? It might be termed a "working lecture." Not only is information given on the various types of seafoods, their nutritive value, what to look for in buying them, storage, preparation, etc.,but six recipes using both shellfish and fish are actually prepared before the audience who then samples the prepared dishes.

Such remarks following the demonstrations, as "Have you any more of those shell-oysters? I have never seen one before. I would like to taste one." or "Oh! that was easy to do. I wouldn't be afraid to try that at home. You make it look so simple!" or such questions as "What's the difference between the red and the brown lobster?" forcibly illustrate the need for additional educational work in increasing the use of shellfish.

While the exhibits and demonstrations have proven tops as far as initial "Interest catchers," there is a real need for something of lasting interest and use in the home and institutions. The answer to this, of course, is fish and shellfish cookbooks - cookbooks for the family, cookbooks for institutions, cookbooks that are well illustrated, easy to follow, and contain a wealth of recipes and information that the homemaker and institution cook feel they can rely upon. In answer to this demand the ultimate plan of the Fish and Wildlife Service is to issue one such cookbook that will cover all phases of fish cookery. However, in order to fill numerous requests and to get the information to the consumer as soon as possible, it has been decided

to divide the book into sections, with each section applicable to some phase of fish or shellfish cookery. As soon as a section is finished, it is published as a Test Kitchen Bulletin and is available for filling requests immediately.

The bulletins published to date, which include FISH COOKERY FOR ONE HUNDRED, BASIC FISH COOKERY, and HOW TO COOK OYSTERS met an instantaneous response, so much so that the Service has been unable to meet all demands due to limited funds available for publications. The original 51,000 copies disappeared like the proverbial hotcake. As a result the Oyster Institute of North America and the National Fisheries Institute stepped in and had 25,000 reprints of HOW TO COOK OYSTERS and 10,000 reprints of FISH COOKERY FOR ONE HUNDRED published; but again this spring demand exceeded the supply and the problem of securing additional reprints of all three bulletins again confronted us. However, during April and May we saw our way clear to have an additional 10,000 copies of each of the above bulletin printed.

With regard to future bulletins, the Home Economics Unit has been working diligently on those which appear to be the most in demand and which consist of the following: HOW TO COOK CRABS, HOW TO COOK SHRIMP, HOW TO COOK CLAMS, HOW TO COOK SALMON, HOW TO COOK ROSEFISH, HOW TO COOK FISH IN A PRESSURE SAUCE PAN.

Each of these bulletins will be similar to HOW TO COOK OYSTERS. The bulletins will contain pertinent information on the market forms, purchasing, shucking or cleaning, and approximately thirty recipes for that particular species of fish or shellfish. The bulletins will have pictures illustrating the steps in preparing one or more of the recipes together with other pictures of the finished dishes ready to serve.

Educational films, we have been told, rank second only to a demonstration and since it is impossible to give demonstrations for all the high schools, colleges, and women's groups interested in fish and shellfish cookery, films have an important place in our educational program. HOME COOKERY OF FISH prepared in cooperation with Encyclopedia Britannica Films, Inc., is the Home Economics Unit's contribution in this field. The film depicts three basic methods of cooking fish, tells the homemaker what to look for when purchasing fish, and shows the resulting attractive dishes when properly prepared. I believe that you will agree with me that a similar film showing the cooking and serving of oysters would have an important place in demonstrating to the homemakers, or the future homemakers of America, the attractive, palatable, and nutritious ways oysters may be served.

In conclusion, it should be emphasized that there is still much educational work to be done in increasing the use of oysters and shellfish in this country. The Home Economics Unit of the U. S. Fish and Wildlife Service will continue, to the best of its ability, to increase the use of oysters and shellfish by giving seafood cookery demonstrations, sponsoring exhibits at national conventions, preparing and disseminating test kitchen bulletins, and aiding in preparing educational films.

A REVIEW OF THE FISHERIES INDUSTRY'S TRANSPORTATION PROBLEMS

V. L. Hodges, Chairman, Oyster Institute Transportation Committee

Chamberlin Hotel, Old Point Comfort, Virginia, June 8, 1949

I shall try to briefly review transportation matters of the past year that may have direct bearing upon the ultimate marketing of oysters. Some developments during the year may eventually prove to be advantageous but, as a whole, they have not been favorable to the interest and welfare of the Oyster Industry.

During the past few years, while prices of oysters were showing a very definite trend toward a lower level, transportation costs were increasing at almost every turn. Rail Freight Rates already have increased approximately 60 percent since 1940. The end is not yet in sight! So far as I know, the Interstate Commerce Commission has not yet handed down a final decision in Ex Parte 168 wherein the Railroads are seeking to obtain a further increase of 13 percent in freight rates. It is my guess, however, that they will get substantially all they asked for.

Express rates have also increased sharply during the same period. Oysters have not fared quite as badly so far in Express rates as have other seafoods. But with our Oyster Tariff - ICC 7350 - expiring with August 31, and the trend being as it is, I feel there is just cause for concern.

Just to show you what may happen, Express rates on fish and shellfish, other than oysters, have already increased in a range of 50 to 115 percent since 1940, with the greater increase applying to points within 750 miles distant.

Not satisfied with these increases, Railway Express Agency issued Classification Docket No. 3 last June, proposing to increase billing weights on fish and shellfish, other than oysters, by an additional 25 pounds per hundred for the weight of ice. This would result in a further increase of 20 percent in transportation charges on fish, and a further increase of approximately 17 percent in transportation charges on shellfish. They had, no doubt, expected to put this change in effect <u>under the rule of publication of notice</u>. However, upon receipt of this notice, members of the fisheries industry got busy in a manner I have never seen displayed before. Following numerous protests and conversations with officials of Railway Express Agency, a meeting was arranged with industry members in Boston around the middle of last September. Despite our best efforts at this meeting to have them withdraw this proposal, we were unsuccessful in having them do so. Subsequently, they filed Supplement No. 24 to Official Classification No. 33 with Interstate Commerce Commission to become effective November 22, 1948. Once again the fisheries industry displayed unified action. I am told that the Commission was flooded with petitions for suspension from all over the country, and, as a result, a hearing was ordered.

Following several postponements, the hearing got under way in Chicago on April 20 before Examiner Rice. No doubt Railway Express Agency had expected to see interest among the fisheries industry to die down in the meanwhile, because I am told they had calculated that the hearing would not extend beyond two to three days. Here again they must have been surprised. This hearing lasted nine days and consumed about 1500 pages of testimony. Not less than 50 industry witnesses were on hand, of which 26 actually presented testimony at the hearing. Witnesses were present from every major producing point in the United States, including Alaska, and from a large number of inland points.

Just what will be the Commission's decision remains to be seen. Final briefs were scheduled to be filed by June 15 but it is most likely that an extension will be required. Based upon the evidence presented at this hearing, I am somewhat inclined to feel that we have better than a 50-50 chance of a favorable decision. But, win or lose, the fact remains that unified action by the fisheries industry will result in this being delayed upwards to a year. Since it has been estimated that the resulting increase in transportation charges from Supplement No. 24 would cost the fisheries industry approximately $400,000 annually, this shows that the fight was worthwhile.

Regulated Truck Lines have also been active during the past year in trying to obtain I.C.C.'s permission to increase rates. So far they have not been successful to any large extent. It does show the trend, however. Obviously, they are anxious and willing to increase their rates also, if and when permission can be obtained. The higher other transportation rates go, the more will be the tendency of Trucks to press for an increase in their rates.

The only encouraging development in this turbulent transportation situation is the possible outcome of the Chester Morton Love Case. Perhaps I should highlight this for the benefit of those who may not be familiar with it. Briefly, the history is this: The I.C.C. brought suit in the United States District Court, Eastern District of Louisiana, New Orleans Division, under provisions of the Motor Carrier Act, to enjoin and restrain one Chester Morton Love from transporting property by motor carrier in Interstate Commerce, for compensation, without holding a certificate or necessary permit. In defense of this suit, Love contended that the vehicles which he operated fell within the partial exemption provision provided in Section 203(b)(6) of the Act. The Court said in part:

> "The Commodities exclusively carried by vehicles of defendant are: (1) fresh headless shrimp, packed in ice; (2) frozen headless shrimp; (3) whole fish; and (4) potatoes. It is rightly conceded by both parties that whole fish and potatoes are exempted commodities.
>
> "Thus the narrow question presented for determination is whether or not the term "fish (including shellfish)" as used in Section 203(b)(6) of the Act embraces fresh headless shrimp, packed in ice, and frozen headless shrimp.
>
> "One of the cardinal rules of interpretation is that the meaning of a statute is to be ascertained from the words used and the subject matter to which it relates. The words used are to be taken in their usual and popular sense, except where they are technical, and then according to the acceptation of those learned in the art. The term "ordinary livestock" as defined in Section 20(11) of the act has a definite and fixed meaning but the term "fish(including shellfish)" is not defined in the statute and since Congress has not limited the meaning of the word "fish" as was done in the case of "agriculture commodities," it follows that the intention of Congress must be gathered from the words unless a literal interpretation would lead to a manifest absurdity.
>
> "Shrimp as handled by the defendant, either fresh headless shrimp packed in ice, or frozen headless shrimp, continued to be shrimp in their natural state. They still remain, and continued to be known as, shrimp. If the Commission's holdings were followed, they would nullify the exemption accorded motor vehicles transporting shrimp, by virtue of the shrimp being beheaded, because no shrimp are transported to the market which are not beheaded. In this way, and through

such an interpretation, the Commission has given no effect whatever to the exemption provided in the statute for fish, insofar as it affects the transportation of shrimp.

"The dissent of Commissioner Lee in the second Division 5 Report fully expresses the views of this court * * *."

The decision of the District Court was affirmed by the United States Court of Appeals, I.C.C. vs. Love, 172 Fed. 2nd 224. The Commission decided not to seek a review by the United States Supreme Court.

Following the decision of the United States Court of Appeals, effort was promptl made by members of the fisheries industry to have the Commission recognize and accept this ruling on a nation-wide basis on all fish and shellfish traffic, other than truly manufactured products thereof. The Commission indicated at an early stage during thes conferences that it would be willing to recognize the decision as applying nation-wide on shrimp only. This was a partial victory, but by no means sufficient; it was realized by members of the industry that it would be necessary to have the Commission to broaden its interpretation to also include other fish and shellfish, including shucked oysters; otherwise, we would be confronted with the risk of similar suits on each item of fish and shellfish until we had completely ran the gauntlet. Accordingly, Ray Steele, representing the National Fisheries Institute Traffic Committee, and James K. Knudson, Chief Counsel of the Department of Agriculture, continued to pursue the matter.

As a result of these conferences, the following action has taken place: Upon order of the Commission, a report has been filed with I.C.C. by Examiner Michael T. Corcoran, who has worked with Commissioner Lee extensively. The report is entitled, "Report on Further Consideration Proposed by Michael T. Corcoran, Examiner," and proposes further consideration in No. MC89207, Monark Egg Corporation Contract Applicatio only as far as "fish (including shellfish)" is concerned. This report was circulated to parties of interest in the Monark Egg Case, and persons desiring to file exceptions were required to do by May 3, 1949.

When the deadline of May 3 passed without any exceptions being filed, we were beginning to feel that we were lucky. It has developed, however, that exceptions were later filed by the Eastern Railroads, by the Class I Carriers in the Western District, and by Railway Express Agency, which were accepted by the Commission. Anothe exception was filed by the New England Motor Rate Bureau but this was not accepted by the Commission because it lacked the necessary certificate of service.

Raymond E. Steele, General Counsel for National Fisheries Institute, responded to the exceptions noted by the Carriers. At this point we do not know what will be the outcome, or what further proceedings in the matter will become necessary. This we do know, however: The Chester Morton Love decision has established a precedent that should be favorable to the entire fisheries industry in event any further suits arise for alleged violations.

Unfortunately, too few members of the fisheries industry display any apparent interest in transportation matters. In saying this, it is not my desire to accuse anyone; I merely wish to awaken the interest of all in transportation problems. Therefore, if I should tread upon your toes, I would like to remind you of any old saying that goes something like this: "Only among true friends do you find one sincere enough to tell you disagreeable truths."

It has been my observation that many are entirely too complacent for either their own welfare, or for the welfare of the industry. I do not know the cause for this apparent lack of interest. It may be that some have completely lost sight of the fact that transportation in one form or another is the connecting link between production and consumption of oysters. Most of you realize, I am sure, that the availability and the cost of transportation can be, and frequently is, the difference between marketing your products profitably or at a loss. Transportation and sales are as inseparable as Siamese Twins. Another thing to remember is this: The consumer is fast getting in that position where he can dictate the price he will pay; consequently, every increase now in transportation costs will have to come largely from your own pockets.

There may be some who feel they have no common interest in the industry's transportation problems because they largely use their own equipment in the distribution of their commodities. Even if this is so, aren't you losing sight of the fact that the Common Carriers - the Railroads, the Steamship Lines, the Franchise Truck Lines, the Air Lines - have all in some manner taken a toll, and have contributed materially to the basic cost of most every commodity you use or consume.

Beyond this, unless I.C.C. should now declare fish and shellfish traffic exempt in a manner they heretofore have not recognized, does a producer or distributor really know where he stands in the operation of his own transportation system? Perhaps many have felt it was their undeniable right to haul their commodities on their own equipment anywhere they wanted, and to include a freight charge in the delivered price if they chose to do so. Strange as it may seem, that question is now debatable. That question is now pending before the Interstate Commerce Commission (the Lenoir Chair Company Case). The issue involved is whether a seller who delivers in his own trucks, and charges the Customer for delivery, is a Common Carrier under I.C.C. regulations.

Beyond this, if those who deliver with their own trucks should elect to not include any freight or transportation cost in the delivered price, is there not then a possibility of violation of the Federal Trade Act? The Supreme Court's recent decision certainly does leave delivered-pricing questions in a muddle. Mind you, I am not expressing an opinion on this; I am merely trying to point out to you that you probably have a bigger stake in industry's transportation problems than you fully realize.

Fortunately, the fisheries industry is far better prepared now to cope with its transportation problems than ever before. One major development was the inclusion of the fisheries industry to obtain certain benefits under the Agriculture Marketing Act. Assistance that has already been given the fisheries industry by the Transportation Division of the Marketing Facilities Branch of the Department of Agriculture cannot be valued in terms of dollars. I know wherein I speak. I have worked with these fellows very closely during the past three years; I have seen them in action. In James K. Knudson, Chief Counsel; Charles B. Bowling, Chief of Transportation and Rates Section; and J. W. Bourke, Chief of the Fisheries Section, we could not ask for more staunch friends or more capable assistance. In addition to these, we have Dr. Richard Kahn, of Fish and Wildlife Service, capable and tireless in his efforts, who has been on hand in every emergency with a vast store of statistical figures and economic data. I doubt we could raise enough money among the fisheries industry to employ talent such as these men have freely given us in their capacity. We owe these gentlemen an expression of gratitude for having gone far beyond any normal requirement of duty to render us the necessary assistance.

We now have within the National Fisheries Institute a Trafffic Committee which I feel is a credit to the industry. This Traffic Committee is composed of members

from each regional zone in the United States. These members freely and willingly contribute their time and talent toward traffic and transportation problems affecting the entire fisheries industry, without any compensation from the Association for either their services or expenses. But the job has grown to be bigger than the Traffic Committee can handle successfully. The real need now, as many members of the Traffic Committee see it, is for a full time Traffic Man on the staff of the Association who can coordinate the efforts of industry traffic members and of Government traffic and transportation officials. This we hope to eventually obtain.

The Oyster Institute, as some of you may know, also set up a Traffic Committee at last year's convention, of which I was named Chairman, I suspect members of the Institute's Traffic Committee may feel that I have been asleep on the job. They would have a perfect right to feel so, based upon my lack of contacts with them, Nevertheless, if any such thought does exist, I should like to assure all that my seeming negligence has been due entirely to a lack of time, and most certainly not because of any lack of desire to work closely with them. Furthermore, I should like to assure you all that oysters have not been neglected in any traffic or rate matters that arose during the past year. In all such hearings or meetings, oysters have been given consideration comparable with fish. This you can readily understand since two members of the N.F.I. Traffic Committee, and possibly others, are fully as much concerned in transportation matters involving oysters as they are in fish or other seafoods.

I believe it to be practical, and I should like to recommend it here and now to the Director and to the Directors of the Oyster Institute, that the Oyster Institute Traffic Committee be authorized and instructed to coordinate their efforts with the N.F.I. Traffic Committee. In doing this there is no reason why the Oyster Institute should lose its individuality or identity; it is merely a matter of trying to get in a stronger position than we are now in. Generally speaking, traffic problems of each segment of the fisheries industry overlap and are just about the same nature. Consequently, what I propose should work out in this way: Any member of the Oyster Institute Traffic Committee who may happen to be exclusive Oyster Man would lend their support in combating traffic problems involving any segment of the fisheries industry. In return, if there should ever come a time when oysters alone become the focal point of attack in any traffic matter, I feel fully confident that you would have the support of substantially every member of the N.F.I. Traffic Committee. I want to make it clear that N.F.I. has not been consulted about this; therefore, if you should think well of my suggestion, it would then become necessary to negotiate this arrangement.

In concluding, I should like to remind you again that it is encumbent upon each member of the oyster industry to give more serious consideration to traffic problems. Give the members of both the Oyster Institute Traffic Committee and the N.F.I. Traffic Committee your fullest cooperation. Please remember, theirs is a difficult and thankless job at its best; they are busy in their own jobs the same as you are; they frequently find it necessary to do a large part of the work involved on their own time. Therefore, whenever any major problem arises where you are needed, be sure to lend your support, your time, and your money - if need be - to see it through. If you are willing to do this, you can have a Traffic Organization within the fisheries industry of which you can feel justly proud. If you are not willing to do this, then please do not expect too much of your Traffic Committee.

I thank you.

THE FROZEN OYSTER INDUSTRY

Clifford F. Evers, Technologist in Charge
Fishery Technological Laboratory, College Park, Maryland

Chamberlin Hotel, Old Point Comfort, Virginia, June 8, 1949

Before discussing your particular industry, it might be well to review briefly the history of the frozen food industry. The freezing of foods as a means of preservation is not new. At least in real northern climates it is probably as old as man. However, the frozen food industry is comparatively recent in origin.

Fish were first frozen commercially about 1865; however, it was not until 1922 that packaged haddock fillets were frozen for the retail market. Unfortunately, no information is available to indicate when oysters were first frozen on a commercial scale. It is known that they were marketed in 1929 when a study was made of the possible acceptance of frosted foods by the homemaker.

Although oysters are highly perishable and are harvested only at certain seasons of the year, relatively small quantities are preserved by freezing. It is estimated that during the year 1945 approximately 75,000,000 pounds of oyster meat were produced and of these, about 7,000,000 pounds were canned and only about 900,000 pounds were frozen.

According to the most recent figures covering only the nearby area known as the Chesapeake Bay Region, approximately 9,700 pounds of oyster meats were frozen during the month of April of this year and the amount in cold storage on May 1st, 1949, was about 105,000 pounds. Those are not very high figures when compared with those covering other frozen foods.

Canning changes the flavor of oysters greatly, whereas freezing changes the flavor only slightly. One would expect that frozen oysters would be in great demand during the summer months, but apparently eating habits are not easily changed.

Perhaps your industry should undertake an educational and promotional campaign. Surely some attempt should be made to acquaint the public with the excellent quality of frozen oysters, and the fact that they are available 12 months of the year. Until this is done the market for the product will be very limited. Since oysters contain only small amounts of fat and carbohydrates and thus yield few calories when utilized by the body, the oyster is truly an excellent hot weather food, and for that matter, is an excellent food at any time of the year.

The freezing preservation of oysters is neither a difficult nor costly project. There are a few simple rules that are commonly applicable to all frozen products, and if these are followed, a high quality product is bound to be the end result. Select fresh, first quality oysters, pack them under sanitary conditions in packages impervious to air and moisture-vapor, freeze them by methods known to yield satisfactory results and store them at low temperatures until delivery to the consumer.

There is little need of discussing the harvesting and handling of oysters in the preparation of oyster meats. The product up to this point is practically in the same condition whether it is to be packed in a can to be sold on the fresh market, or in a package for freezing.

In the East, the most popular size of oyster meat for freezing is the select, and they are of such size that one gallon contains more than 210 oysters, but not more than 300 oysters. Freshly opened oysters are passed over a skimmer or a riffle board, where they are given a preliminary washing to remove loose sand and pieces of shell. Here they are thoroughly inspected and all discolored or otherwise objectionable meats are removed. From the skimmer the oyster meats flow into stainless steel or monel metal tanks, usually in batches of about twenty gallons, where they are usually washed with water or brine while being agitated with compressed air. Some packers prefer fresh water for this washing and others use salt water. Obviously a packer will increase his yield if the oysters are blown in fresh water. Such treatment just prior to freezing yields a product that will have excessive leakage or drip, on thawing and such oysters will be rather flat in flavor. However, if the oysters are blown in water of a salinity slightly higher than that in which they are grown, their original flavor will be maintained and less leakage will occur on thawing. Here we are at the old argument again, quality versus quantity and it is up to the individual packer to decide which he wants. A happy medium is ideal, but very difficult to attain.

Following agitation, the oyster meats are drained free from water and are then packaged for freezing. As with all frozen foods, proper packaging of oysters to be frozen is of great importance. The product must be protected from loss of moisture during storage. Otherwise there will be desiccation or freezer burn. Also, the product must be protected from contact with air in order to prevent the oyster meats from discoloring and turning dark.

Most packages for frozen foods consist of two or three separate parts, a container, an inner bag or liner, and quite often, an overwrap. Rectangular waxed paperboard containers, also called folding boxes, are the type of container most commonly used. Some are end opening or end fill, whereas others are top opening or top fill. Heavily waxed tubs and cups may also be used and likewise tinned containers, although in recent years, none of these have been very popular for frozen oysters.

The inner bag may be made of cellophane, specially coated paper or parchment, or of other moisture vapor proof material. The use of a cellophane inner liner in place of a bag will supply the necessary protection during cold storage, but in that case one must be certain that the outer container will hold the liquid part of the package before and during freezing and during thawing.

When a bag is used, it must be thoroughly opened out at the base before being filled. After filling, all air should be carefully forced out and the top of the bag should be folded and heat sealed.

The outer wrap adds little to the protective quality of the package but is used either to protect the appearance or for brand identification purposes. Carton wrappers may be cellophane, waxed paper or aluminum foil.

The new metal end paperboard containers now being produced by the leading can companies have had wide acceptance for frozen fruits, and perhaps studies should be made to test their adaptability to frozen oysters. The use of these containers makes possible high-speed, automatic filling and closing operations, thereby resulting in a considerable saving in labor.

The use of a packing medium, such as the strained liquor from the shucked oysters, will do much to eliminate the danger of surface desiccation and also

fill up the voids, thereby preventing contact of the surface of the oyster meats with air. The use of a packing medium is a very controversial point and may lead to problems involving federal and state laws. Nevertheless from the standpoint of good freezing preservation, it is something that might well be investigated from a legal angle.

With or without the use of a packing medium, care must be taken not to fill the packages completely. During freezing, oyster meats expand about seven percent and headspace must be provided to take care of this expansion or else the containers may bulge badly and even burst.

The freezing of oyster meats is really a very simple matter and the speed of freezing is not nearly as important for oysters as it is for most frozen foods. Slow frozen oyster meats will be a little less tasty and will give a somewhat greater leakage, but neither to the extent that good quality is completely lost. However, if reasonably quick freezing processes can be used, they are highly recommended. Excluding patented processes, each packer has his own little ideas and improvements on how to freeze packaged products, and in all probability, most of these individual systems of freezing are doing a good job. In this brief talk, time does not permit a full description of freezing machines, but I will be only too glad to answer your questions in a discussion period or later in the day.

Following freezing, the frozen packaged oyster meats should be cased either for temporary storage or subsequent shipping, and stored at 0°F. It is a generally accepted fact that the lower the storage temperature the less noticeable are the changes occurring during storage. At 0°F. storage, properly packaged oyster meats should remain in a satisfactory condition for one year.

Frozen oyster meats should never be permitted to thaw until required for use. Therefore, great care must be used during transportation and marketing to insure that they reach the consumer in a frozen condition.

Frozen oyster meats may be used for all purposes for which raw shucked oysters are used. By packing and selling frozen oyster meats of good quality, your industry should have an excellent opportunity to expand the market for oysters. The freezing preservation of oyster meats should do much to steady the market and prevent gluts and the losses that go with overproduction. However, as a word of caution, do not attempt to freeze oysters that are on the verge of not being saleable; in fact stop your selection far ahead of that point, and freeze only those oyster meats that are absolutely fresh and in the prime of condition. During the war years many in the frozen food industry packed some mighty poor quality merchandise and the industry as a whole suffered a terrific set-back. Always remember that quality and quality control pay dividends.

Before concluding this talk, I would like to add another project for possible study. You will perhaps recall that I mentioned one under packaging, namely, a study of the adaptability to frozen oyster meats of the new metal end paperboard containers. Another study worthy of consideration involves the use of antioxidants. Some ten years ago, Tressler and DuBois discovered the value of ascorbic acid (Vitamin C) for retarding the discoloration of frozen peaches. More recently other investigators have experimented on the use of ascorbic acid for retarding rancidity in frozen fish. Still more recently DuBois reports that the addition of ascorbic acid to oyster meats prevents the discoloration that is sometimes found in the defrosted product. Further studies along these lines should be made for the benefit of your industry.

WHAT CAN SCIENCE OFFER THE OYSTER GROWER

Thurlow C. Nelson, Ph.D., D.Sc.
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Biologist, New Jersey State Division of Shellfisheries
In Charge, New Jersey Oyster Research Laboratory

Chamberlin Hotel, Old Point Comfort, Virginia, June 8, 1949

Introduction

As we gather here today on the shores of historic Chesapeake Bay to discuss the problems of the great shellfish industry I am deeply conscious of the debt we owe to this area. It was here in Chesapeake Bay that the great biologist, the late Dr. William Keith Brooks of the Johns Hopkins University, undertook the first studies of the oyster in America. In 1878 he organized the Chesapeake Zoological Laboratory and during the following twenty-eight years during warm weather he was always at the seashore accompanied by a party of students. In keeping with the early traditions of the John Hopkins, the available money was mostly put into brains, not into buildings and boats. Starting with a vacant warehouse at Fort Wool and three rowboats furnished by the Secretary of War, the group moved the next year into three barges of the Maryland Fish Commission at Crisfield, Maryland. In 1883 the laboratory was located in a building leased from the Normal School in Hampton, Virginia, but a few moments drive from where we are now gathered.

Thus we meet today in the very heart and home of oyster research in America. May we pause for a moment to pay tribute to this great scientist. As Chairman of the Maryland Oyster Commission Dr. Brooks submitted to the General Assembly of Maryland in 1884 a comprehensive report on "The Development and Protection of the Oyster in Maryland." If his recommendations had been followed there would be only one oyster problem for Chesapeake Bay today; where to find markets for the vast numbers of oysters produced on the prolific reefs of this area.

Of greater value to the country as a whole, however, has been the legacy Dr. Brooks left us in his students; Dr. James L. Kellogg, long of Williams College Massachusetts, whose work on molluscs has yet to be surpassed and whose student, David Belding, made such substantial contributions to the oyster, quahaug and scallop fisheries of Massachusetts. Dr. Caswell Grave for some years biologist of the Maryland Oyster Commission whose student Dr. E. P. Churchill initiated the program of research on oyster larvae of the Fish and Wildlife Service. Lastly the even greater work and influence of my father, the late Dr. Julius Nelson at Rutgers, who lives on not only in your speaker but in William H. Dumont and in Jim Engle of the Fish and Wildlife Service, in Dr. C. A. Perry of the Maryland State Department of Health and Dr. C. Roy Elsey of British Columbia, in Dr. L. A. Stauber, Dr. H. H. Haskin, and Dr. M. R. Carriker now at Rutgers, and Dr. A. F. Chestnut of the University of North Carolina's new Institute of Fisheries Research at Morehead City. Here also I must include my brother, Mr. J. Richards Nelson, who while still a student at Rutgers fell under the influence of the Brooks tradition and switched his loyalties from poultry husbandry to oyster farming. Through these men may this great scientific tradition carry on in ever widening circles.

The Needs of the Industry and the Accomplishments of Science

The primary and basic needs of the oyster industry are:

1. A dependable supply of seed
2. Protection from enemies
3. Good growing and fattening grounds
4. Protection from industrial and domestic pollution

What has science actually contributed thus far to the welfare of the industry and what prospects are there for the future?

1. Obtaining seed oysters

During the first decade of the present century Dr. Stafford in Canada and my father, the late Dr. Julius Nelson of Rutgers College in New Jersey, studied and described the free swimming stages of the oyster larvae and the conditions under which they are able to attach. The slide shows the first photograph ever taken of an oyster larva. It was made by my father in 1908 and published in his annual report in 1909. In represents a larva 9-10 days old. To these two scientists must be given credit for first demonstrating the importance of clean shells as cultch. They showed that spawning of the American oyster begins at a temperature close to 70 degrees Fahrenheit and that it is possible through microscopic examination of the water to determine the probalbe time and intensity of the expected oyster set.

Following the death of Dr. Julius Nelson in 1916 his work was expanded in that year at the New Jersey Station to include the world's first survey of an oyster bearing area to determine the abundance and age of oyster larvae at different points. This survey of Little Egg Harbor, published in 1917, demonstrated: first, that the oyster larvae work upstream away from the sea; and second, that through determining the age of the larvae the time of expected set could be predicted ten days in advance.

The advent of the first World War interrupted all oyster research, but the decade beginning in 1920 saw greater progress in oyster research and wider application of its findings than in any comparable period in our history. Lack of time prevents me from more than mentioning some of the more important discoveries. Churchill and Gutsell of the U. S. Bureau of Fisheries, working in Great South Bay, Long Island, confirmed our findings in Little Egg Harbor and Barnegat Bay, paving the way for the outstanding work of Prytherch and Engle and their associates at Milford, Connecticut. Meanwhile Joe Glancy and Wm. Firth Wells working quietly for the New York Conservation Department were the first to raise oysters from the egg to setting size. Dr. Galtsoff, newly arrived in this country from the marine station at Sebastopol on the Black Sea, joined the Bureau of Fisheries and plunged into a study of the oceanography of Long Island Sound especially as related to the oyster industry.

The story is an exciting one, typical of what we like to think as being truly American. Great industrial expansion incident to the First World War let loose a flood of industrial wastes that threatened by 1924 to wipe out the great oyster setting grounds of Brideport and New Haven harbors.

The personnel and financial resources of the U. S. Bureau of Fisheries were thrown into the struggle, in which they were joined by two men of outstanding ability and vision. To them we scientists and oyster growers of America owe eternal gratitude

The vision and the industry of Mr. Howard Beach gave us the Oyster Institute. His confidence in Dr. Radcliffe as its Director has been abundantly justified in the years that have followed. The Institute, and the Milford Laboratory are monuments to these two men.

Supported by the valiant work of our late lamented Captain "Shang" Wheeler in Connecticut, and of Dr. Connelly in Rhode Island, pollution was greatly abated, inshore spawning areas were restored and the great Long Island oyster industry was saved. How typically American is this story, science and industry working together hand and hand to solve our common problems. The very valuable bulletins issued by Dr. Loosanoff at Milford are the latest evidence that through the aid of science oyster sets of abundance can be obtained in nature.

Of vital interest in the possible role of spawning sanctuaries in increasing seed production is the important question of how far may oyster larvae travel during their two weeks of free-swimming existence.

The only unquestioned proof of distance traveled by an oyster larva of which I know is that of Dr. Roy Elsey of British Columbia who found a spat of the Japanese oyster attached to a boulder estimated at approximately five tons and situated some five miles from a bed of Japanese oysters introduced the preceding summer. There were no other Japanese oysters in the area and that boulder certainly wasn't dropped off an oyster boat!

In Delaware Bay we have indirect evidence that in some seasons vast numbers of oyster larvae may be carried upstream as much as fifteen miles from the planting grounds to set on the natural beds above.

Where spawning sanctuaries have been set up we have repeatedly found much heavier sets up and downstream from the parent oysters. This would seem to support Prytherch's findings at Milford that larvae remain close to their parents throughout the entire two weeks larval period. Another explanation, however, is possible. In 1921 I described and pictured 62 mature oyster larvae ready to set from the stomach of an adult oyster. Such larvae do not remain long in the digestive tract of the adult oyster, but are quickly carried out of the intestine. On emerging from their accidental prison they have frequently been seen to push out foot and velum and to swim away. Two years ago a group of large oysters were brought to Surf City, Barnegat Bay, from a distance of some eight miles. Less than two weeks later a heavy set approximately two weeks old was found on the oysters themselves and upon nearby gravel. There were no parent oysters in the area save a couple of bushels of small oysters in trays. The heavy set, confined to the shells of the large oysters and the gravel all within a few feet strongly suggests that there were larvae in the guts of the big oysters when brought here and that on planting, the large oysters liberated their load of captured young which promptly set in the immediate neighborhood. With hundreds of thousands of oysters each pumping twenty, thirty or more quarts of water an hour vast numbers of oyster larvae must be captured and subsequently liberated. Absence of such capture by the adults may well be an important factor in the failure of a depleted oyster bed to rehabilitate itself. It deserves much further study. Here is a field where radioactive tracer elements can be used to great advantage.

After twenty years experience on the Cape May shore of Delaware Bay we can give you the following as definite facts. During eighteen of these twenty years intensely heavy sets of oysters have occurred upon the flats within a few feet of our

laboratory. Setting has taken place continuously night and day for from four to as much as ten weeks as determined from shells placed and removed each 24 hours. As high as 600 spat per concave surface of a quahaug shell have struck within a single 24-hour period, with over 100 per shell each 24 hour period for more than two weeks. Since the flats run bare each low tide to a distance of 2500 feet, the larvae must be carried at least that distance with each flood tide. The only oysters seaward from our laboratory are on a small depleted natural bed - the Drum Beds in the public quahaug area. We are forced to conclude therefore, that the bulk of these larvae are produced on the planted beds above us and are carried seaward during early development. By successively sinking on the ebb and rising on the flood they return to our New Jersey shore. Due to the effects of the rotation of the earth they are carried toward the Delaware shore during ebb tide while being borne toward the New Jersey side as the tide swings to the right with the flood.

Outside the bar, situated some 3000 feet from the high water mark, and in 14 to 20 feet of water are hundreds of acres of oyster bottom which have been heavily shelled year after year. In the main these shells have caught fewer spat in an entire summer than attach to similar shells in one tide close to the shore. It is evident therefore that with each flood tide these larvae by countless billions pass by these shells to attach to shells in shoal water on the flats. We have had excellent success moving such heavily set shells offshore into deeper water when the oldest are but 10 days of age.

It is my opinion that no more important problem faces the Chesapeake Bay area than to determine the role of parent oysters in capturing their young and finding out how far the larvae are carried. Here is a field in which radioactive tracer elements or even staining as used by Dr. Loosanoff could be employed to great advantage. It is understood that Dr. Chipman has recently completed the training required in handling radioactive elements. May I urgently recommend the tracing of oyster larvae for his early consideration.

2. Oyster Enemies

Much has been learned about the enemies of the oyster but so far science has yet to give us methods for the control of oyster enemies comparable to these developed for the eradication of insect pests, for example. Since boring snails are also molluscs, breathing through gills, they are so close to the oyster that it is very doubtful if any method of poisoning them can be found which will not harm the oysters or render them unfit for human food. The plan to kill oyster drills through corrosive sublimate, or bichloride of mercury, as recently proposed appears highly dangerous through the habit of the oyster of loading up with heavy metals such as zinc, bismuth, lead, mercury or copper whenever these occur in appreciable quantities in the surrounding waters.

The six year study of the oyster drill, Urosalpinx, carried on by Dr. L. A. Stauber at our laboratory with the aid of W.P.A. and P.W.A. funds showed conslusively that three methods of control are effective and that their use will pay dividends. Where much new shell growth is present on the oysters the drill trap should be used. This is a chicken wire bag filled with oysters younger than those which it is desired to protect. Oyster growers have long known that drills will attact the youngest oysters available while, Dr. H. H. Haskin in our laboratory proved that drills can distinguish between the excurrent water coming from oysters of different year classes up to four years of age. Bags of young oysters strung on trot lines will confer much protection to oysters on the bed. If placed around a bed comparatively

free from drills such bags if frequently shaken to remove the drills will largely prevent invasion from adjoining beds. For use in transplanting we strongly recommend either the deck screen or deck plate of steel with holes closely bored to let the drills through. For cleaning a ground before planting we recommend the drill dredge.

Starfish are destroyed by quick lime but this cannot yet be considered a substitute for mopping. Much of the difficulty comes from vast populations of starfish on barren bottoms from which the free swimming larvae may be carried long distances in a few days. Discovery of an economic use for starfish would stimulate a fishery for them thus keeping down their numbers on the barren bottoms. A few years ago I was greatly interested as well as amused to overhear a well known zoologist who spends his summers at the Woods Hole laboratory on Buzzards Bay, Massachusetts, express the fear that inroads on the starfish of that area to supply biological laboratories would soon so reduce the number of those animals that it would be difficult to find enough for his own research work. You men from the Long Island Sound area will smile at this, but does it not hold a lesson for us; that steady pressure on any species over an extended period will reduce the population to small proportions?

Great hope for oyster pest control in the future lies in the work of Dr. Sewell H. Hopkins and of his numerous associates of the Texas A and M Research Foundation working in the Gulf. I look forward also with anticipation to what Dr. Prytherch will tell us shortly of his control of oyster enemies in North Carolina. Of this much we can be certain. When oysters are planted on new bottom relatively free from enemies the returns are often very large. With each succeeding year, however, the oysters' enemies increase and unless these are brought under control may ultimately put the oyster grower out of business. The boom years of 1920 to 1930 in Maurice River Cove are a good illustration. New bottoms were being taken up where oysters had not previously been planted and hence were comparatively free from drills. Aided by the wettest year in New Jersey's history more than five million dollars worth of oysters were shipped from the Cove in 1928, putting New Jersey in third place among the states with a production of one seventh of the total oyster crop of the United States.

With the onset of the depression new grounds were not taken up, three of the driest years of record plus a hurricane took their heavy toll, with drills and the mud worm, Polydora, reducing the oyster crop by approximately one half. New Jersey slipped back into fifth place among the states. Return to our former position can only be accomplished through vigorous control of oyster pests; especially the drill.

3. Favorable growing and fattening grounds

Here science has been of little help; the oyster grower has had to depend almost wholly upon his own experience and that of others. We do not yet know why oysters grow well on some grounds, poorly on adjoining grounds, Even on the same ground, as every oyster grower well knows, growth and fattening may be good one year, poor the next. Much scientific work has been done in this field but as yet there is little that science can tell you of practical value. From our experience in New Jersey we know that when the diatom Skeletonema is abundant we have had fat oysters of excellent flavor. We have seen oysters increase in yield almost a pint per bushel in one week following a heavy invasion of this diatom. When associated with objectionable forms such as the "gremlin" Bicoeca in Great South Bay in 1943 oysters may remain thin and poor even in the presence of abundant Skeletonema.

Our experience in New Jersey does not support the conclusion of Dr. Loosanoff and his coworkers that oysters in nature will not feed in the presence of thick suspensions of food organisms. We have found oysters to feed actively throughout dense swarming of the dinoflagellate Amphidinium fusiforme, when the water had turned red and was a veritable soup of these algae and of their zoospores. Since Dr. Loosanoff's observations were made under laboratory conditions while ours were made in the open waters of Delaware Bay it is probable that poisonous substances produced by the algae at Milford were either not present in Delaware Bay or were quickly destroyed in our open waters. I have to be shown before I will believe that oysters will starve and die in nature in the midst of abundant food.

4. Protection from industrial and domestic pollution

Although in the past some oyster growers have looked upon bacteriologists as their worst enemies, we must all agree that in the main sanitary standards have aided and protected the industry. It is encouraging to find the United States Public Health Service now engaged in active research looking toward new techniques for identifying objectionable bacteria and to sounder more reliable methods of determing the sanitary quality of shellfish. Federal and state attack on aquatic pollution is being actively pushed in many quarters, industry is cooperating as never before, ready to spend money liberally for research on waste disposal. Noteworthy is the two million dollar project of the U. S. Public Health Service which will be launched July 1st for the control of stream pollution.

Concrete evidence of improvement of the waters of New York Harbor is seen in a group of oysters on exhibit in this room. The late Captain Will Elsworth told me in 1923 that he had caught his last oysters in the lower Hudson River in 1917 close to the Statue of Liberty. Exhibited here today is a group of excellent oysters dredged last December on Robbin's Reef within the very shadow of the Statue of Liberty. One is tempted to become somewhat sentimental and to suggest that even the lowly oyster is enjoying the protection of our Goddess of Liberty.

Finally we shall learn during this convention of the excellent progress made by Dr. Loosanoff and his associates in raising oyster and quahaug larvae to setting size at the Milford laboratory. Armed with such technique there is every reason to hope that through selective breeding we can obtain oysters and quahaugs capable of attaining market size in half the time now required. From the growth studies of Martin and ourselves in New Jersey and of Dr. Loosanoff at Milford we know that certain oysters in any lot will outgrow others by as much as ten to one. In my own studies of water pumpage by oysters it has been found that two year old Cape May oysters selected through rigorous competition in the heavy sets of that area, can out-pump eight year old Barnegat Bay oysters grown from non-selected seed, by at least two to one. Since the oyster must obtain the materials for growth and fattening from the water which it pumps, it follows that ability to pump water is probably the most important characteristic of a vigorous oyster. Unless the oyster is very different from most other animals such vigor is inherited in at least a portion of the offspring. Selection of the fastest growers in each succeeding generation should soon give us an oyster comparable to the large Pacific oyster imported from Japan which has in 18 months reached a size where 8 of them will make a pint. This may sound fantastic but science has produced equally miraculous results with other domestic and game animals such as trout; why not with oysters? To accomplish our goal research positions in the shellfisheries field mu be made sufficiently attractive in salary and in tenure to interest young men of abili and with adequate training. Above all they must have complete independence of, and pro tection from, political interference. Looking back over half a century it is clearly evident that bad politics has been a far worse enemy of the oyster than pollution, sta fish, drills and all other natural enemies combined. You in the industry have the political power to protect the scientists who are ready and eager to serve you; their fate is largely in your hands in a future that is bright with promise.

VARYING CHARACTERISTICS OF OYSTER BOTTOM

Allan A. Sollers, Commissioner
Maryland Department of Tidewater Fisheries

Chamberlin Hotel, Old Point Comfort, Virginia, June 8, 1949

An oyster, Mr. Chairman and friends, is the one thing in the world that I envy. The lazy rascal spends just about his entire life lying in bed. To complicate the matter further, this fastidious gentleman is a bit particular about the kind of bed he lies in. If it is too soft he settles in and dies. If the bed is too hard and shifting he likewise is covered up and departs for the oyster spirit world.

Hence we are compelled to take due notice of these eccentricities of our exacting bivalved associate; our personal economic welfare is dependent on it. The uninitiated, though otherwise well informed, might quickly ask, "Why haven't physical and chemical analyses been made of the submerged lands, the several classes established, and these classes correlated with their capacity to grow oysters?" He would doubtless substantiate his question by pointing out the work done by the agricultural experiment stations ashore and refer to the glib way that farmers speak of loams, clays and sandy soils, marls and the host of other classifications in that book.

Such a classification might be useful; I have discussed the question with those qualified and have never discouraged such an attempt. I have by the same reasoning never strongly advocated such an effort for fear of oversimplification. There is more to the problem than would show in a simple physical analysis of the ground in question. I will discuss variations, complications and exceptions later.

If an attempt were made to classify the submerged lands, the Chesapeake Bay would be a good place to make it; surely we have every combination in the world there, and maybe one over for good measure. Three general classifications would be immediately apparent.

The first to attract attention would be the sands along the shore lines. They feel relatively hard and firm to the bare feet of bathers but they lack any adhesive or cohesive qualities and shift about with the pounding of the surf. Their extent off shore is dependent on the degree to which the area in question is exposed to heavy seas.

Second, just beyond the shifting sands, we again find sand, but something has been added. Mixed with the coarse grains of sand, there are smaller particles that possess definite adhesive qualities. I am not sure what these smaller particles are, probably some type of clay. In any event they hold the grains of sand in a fixed position in much the same manner that the crystals in babbit bearings are held by the soft metal around them. The relative amounts of the component materials vary widely, but as long as both are present we have a firm, stable ground that remains amazingly constant. This is the combination of constituents of the natural oyster rocks of Maryland. Here we find the seventh heaven or the happy home of the ovster in our State.

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Third, beyond these reefs or bars the percentage of sand sharply diminishes and we are on the mud. Generally the mud bottoms are definitely not the best places to grow oysters. I hasten to concede that there are great differences in the quality of mud bottoms, but do not feel that I should take the time at this point to discuss even the little that I know about these variations. I leave the point with the admonition that mud bottoms are bad places for uninitiated oyster planters who are long on ambition and capital and short on experience.

If the three classifications set forth above doubtless make the problem seem easy and simple, I hasten to dispel that illusion. For instance, there is another class. I set it forth as an exception because it appears pretty much without rhyme or reason in relation to the pattern set out above. The geologists call it Plum Point Marl. There are more local names for it in Maryland than there are sinners in Hades. Some of the local names are Fullers Earth, Blue Clay, Foolish Earth, etc.; you may take your choice. Generally it is excellent oyster ground. It will not shift under the most severe pounding of the seas. Again, generally, it appears in pure form; that is, not mixed with sand or mud. I know of a couple of exceptions. In Poplar Island Narrows in Maryland and off Port Mahan in the Delaware Bay is to be found an admixture of this blue clay and mud. The combination is somewhat softer than the pure clay and the blue color is lost. The mixture is black or nearly so and is called mud, locally. The combination makes an excellent oyster bottom in spite of the fact that those immediately concerned appear to be at a loss to explain why.

I said a moment ago a simple classification as indicated might be deceptive. Mr. Engle of the Fish and Wildlife Service will read you a paper describing a splendid piece of research work he has done in Eastern Bay, a tributary of the Chesapeake. A brief discussion of the kind of oyster ground found there might be worthwhile for it shows the influence of another environmental factor and definitely does not fit the pattern set forth. The place is simply an oversized sand pit. In the state service I have had to deal with it, and I frankly say that the place kept me talking to myself until I finally figured it out.

Here I found oysters growing on loose sand, the type of sand that sensible oysters would not be caught monkeying with. Contradictory or not, they do grow there. Here are the observations and the conclusions. Eastern Bay has a very irregular shore line and is dotted with several small islands. Long narrow peninsulas nearby bisect it. There are many oyster bars. It was noted that the bars began at varying distances from shore. In some instances the bars began in two or three feet of water, in others it was necessary to go off shore until a depth of fifteen or sixteen feet was reached before oysters and the inner edge of the bars were found. When this depth factor was correlated with the depth and extent of the open water to windward, the answer was apparent. The oysters grew on the loose sand as soon as the depth of the water became sufficient so that the impact of the seas would not shift the sand about.

This paper would be incomplete without some mention of the loess of the sea. In some arid regions of the earth, interior China for instance, this material drifts about with the winds. In our element, the water, we call it quicksand. It is death to oysters and forms the building material for the siliceous tube worms, sand coral or coral sand according to where you live.

It would be fine if one could pick up a sample of some oyster bed, run to a laboratory and receive definite and final assurance on the survival of oysters on it.

Your speaker, in the absence of more precise methods, has learned to determine the quality of oyster ground with the simple devices generally at hand. These include sounding poles, orange peel bottom samplers and tongs. He would be glad of a more precise system of determination, but is wondering how long it would take him to get used to the new method.

The situation reminds me of a story told years ago, in steamboat days, about a waterman in my section who had spent most of his time on old schooners and work boats. He married and decided to go to Baltimore by steamboat for a honeymoon trip. The transition from simple sail to the luxury of steam presented problems. The first to bedevil him was the purser. Recognizing him as the bridegroom, the purser asked, "Do you want the bridal suite?" Appreciating the fact that this trick would cost him money, our friend asked, "What is the difference between that and the others?" "Oh, the bridal suite has a private bath," was the purser's answer. After a moment's hesitation the waterman replied, "Just a minute, Mister, I'll go ask my wife, for my part if I get seasick or something I'll run to the rail like I been doing."

I have never insisted on the study indicated in this paper, for I might be too much like the waterman just referred to. Confronted with the problem of determining the quality of a piece of oyster ground, I am afraid I would grab a sounding pole, go over the area in question and make a final decision without further ado.

The absence of the information and the classifications indicated in this paper are no fault of the scientific organizations. They are biologists and chemists not mind readers. It is up to the industry to make its wants known. If you fellows think that such a study would be useful, let's ask that it be made. It might prove useful beyond our wildest expectations.

VARIATIONS IN INTENSITY OF SETTING OF OYSTERS IN LONG ISLAND SOUND

Dr. Victor L. Loosanoff, Director, U. S. Fish and Wildlife Service
Milford, Connecticut

Chamberlin Hotel, Old Point Comfort, Virginia, June 8, 1949

A good set of oysters in northern waters, including those of Connecticut, is not a rule but an exception. For example, of the past twelve seasons only four gave commercially important sets. Lightness and irregularity of setting are the chief handicaps of the oyster cultivators of Long Island Sound because the latter can never be assured that a new generation of oysters will be available to repopulate the beds.

At present the causes responsible for variations in the intensity of oyster setting in Long Island Sound are not fully determined and understood. Nevertheless, during the last twelve years, 1937-1948, enough new data have been collected which may help clarify some aspects of this important and interesting question. It is the purpose of this article to discuss some of the causes that may influence the intensity of setting.

We know that any species, in order to reproduce, should have a sufficient number of individuals to act as parents. Were our oyster beds depleted to such an extent that not enough spawners were present, lack of set could be ascribed to that cause. However, this probably has never occurred in our waters because there are always several million bushels of adult oysters in and near the area of the setting beds guaranteeing enough spawners. We cannot, therefore, consider the lack of spawners a cause responsible for the lack of set.

In some areas the failure of oysters to spawn could be advanced as a reason for the failure of setting. As a matter of fact, in some earlier articles discussing spawning of oysters opinions were expressed that in the deeper water of Long Island Sound oysters spawned only once in ten years (Nelson, 1928). Our observations showed, however, that this is not so. We found that oysters develop gonads and spawn every year. While the thickness of the gonads may vary from year to year, nevertheless, each year anough spawn is accumulated at the beginning of the spawning season.

There is no reason why the oysters in Long Island Sound should not spawn annually. Our records show that the summer temperature of the Sound is always high enough for the development of gonads and for inducing spawning. In depths up to about 40 feet a temperature of 20.0°C. or higher is maintained from about July 20 to September 15 or 20, i.e.,approximately 55-60 days, a period long enough to permit the oysters to discharge their gonads completely. Even at the depth of 100 feet the temperature reaches 21.0 or 22.0°C. The majority of the oysters complete their spawning by about the first of September, approximately 15 or 20 days before the temperature begins to decrease below 20.0°C. (Loosanoff and Engle, 1942). Thus, failure of setting in our waters cannot be attributed to the failure of oysters to develop gonads and to spawn.

The failure of some aquatic species to propagate has been explained by the reaso that a large number of the eggs discharged remained unfertilized and later perished (Thorson, 1946). This explanation cannot be applied to our oysters because, in their case, usually a large number of individuals spawn simultaneously, and this mass spawning insures fertilization of the majority of the eggs. On several occasions we

observed spawning of oysters on the shallow bed of Milford Harbor. During the spawning the water over the bed was rendered milky with the discharged eggs and spermatozoa. Examination of the eggs showed that all were fertilized, thus indicating that there wa no appreciable waste of eggs. A similar situation probably exists in the deep water beds. It is doubtful, therefore, that failure at fertilization is a cause responsible for the production of the small number of larvae.

On the basis of the presented considerations we may conclude that in Long Island Sound a sufficient number of oyster larvae is produced each year. These larvae are planktotrophic with a long free-swimming or pelagic life which, in our waters, is about 18 days. Larvae of this type, as Thorson (1946) points out, are "cheap" because the eggs from which they develop are small, containing little yolk and, therefore, they can be produced in extremely large numbers. However, the initial advantage possessed by the oysters in producing a large number of eggs and larvae is counterbalanced by several disadvantages the first of which is, perhaps, the long larval period. During this period the larvae are exposed to the attacks of their enemies and are entirely dependent in their development upon the presence in the water of certain plankton forms which serve them as food. Furthermore, during this period the larvae are also exposed to continuous changes in their environment some of which may cause heavy mortality or the complete disappearance of broods of larvae.

Before proceeding to discuss the conditions that may, or may not, be responsible for the mass disappearance of larvae we should, perhaps, become familiar with the major events of the propagation of oysters in Long Island Sound, In the past a rather complex formula was offered for prediction of the time of the beginning of spawning and setting(Prytherch, 1929). We find, however, that the situation is less complex than it appeared to earlier investigators. Our observations showed that spawning in Long Island Sound always begins either during the last few days of June or during the first days of July. The earliest date of spawning recorded was in 1945, on June 26, and the latest, in 1937, on July 3. Thus, in twelve years the beginning of spawning was confined to a calendar period of only eight days. We may be justified, therefore, to conclude that in Long Island Sound the beginning of the oyster spawning season should be expected on June 30 ± 4 days.

The beginning of spawning occurred at every lunar phase ranging from new moon to the last quarter. It was not related to definite tidal changes and, therefore, to the changes in hydrostatic pressure.

The earliest beginning of setting was recorded in 1941, on July 15, and the latest, in 1943, on July 23. Thus, in twelve summers the beginning of setting was confined to only about nine calendar days. Although it most often took place on July 17, we may, nevertheless, suggest that, for all practical purposes, in Long Island Sound the beginning of oyster setting should be expected on July 19 ± 4 days. The beginning of setting also happened at every moon phase and was not confined or even closely related to a definite tidal condition.

The formulae offered are based upon our observations which, I believe, are extensive enough to justify suggesting them. They should be found correct in the majority of instances but, nevertheless, we do not maintain that they should remain forever infallible. Some extremely abnormal conditions, not encountered thus far in our experience, may either hasten or retard spawning, or shorten or prolong the larval perio to such an extent that the beginning of spawning or beginning of setting would take place outside the limits given in our formulae.

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The setting season in Long Island Sound is of comparatively long duration. It usually extends from the third week of July to the end of September, and sometimes even to the first days of October. However, the intensity of setting in time does not follow a rigid pattern from year to year but shows several variations. For example, in 1940 the first wave of setting was extremely heavy while the second wave was relatively light. In 1942, however, heavy setting came late in the season as part of the second wave. In 1944 setting continued almost uninterrupted during the summer but again the first wave was much heavier than the second. Finally, as in 1948, there may be two waves of setting of almost equal importance. In the latter case two distinct waves with pronounced peaks or maxima were especially well demonstrated.

The date of the peaks of setting showed no relation to the date of the beginning of spawning. In twelve years of observations the periods elapsing between the beginning of spawning and the day of maximum setting of the first wave varied from 16 to 40 days and averaged 30 days, and the beginning of the second wave varied from 47 to 66 days and averaged 56 days after the beginning of spawning. In time the date of maximum setting of the first wave varied from July 19 to August 10 and the second wave from August 25 to September 12. These variations show that it is difficult to predict with any degree of accuracy the dates of maximum sets.

In search of signs of periodicity in the occurrence of the peaks of setting the number of days elapsing between the dates of maximum settings of the two waves of each year was determined (Table 1.). The number of days for the year of 1938 is not shown in the table because the late setting in that year was a complete failure. The longest period between the two peaks was recorded in 1937, when 53 days elapsed between these two events. The shortest period of 23 days was noted in 1944. In the remaining years the period between the two peaks ranged between 28 and 38 days. Thus, as can be seen, setting of oysters not only varies in intensity from year to year but the peaks of the setting also do not show a definite time pattern.

TABLE 1. Number of days elapsing between the dates of maximum setting of first and second waves, Long Island Sound, 1937-1948:

Year	Days	Year	Days	Year	Days
1937	53	1941	38	1945	28
1938	30	1942	38	1946	34
1939	36	1943	--	1947	35
1940	31	1944	23	1948	37

What are the conditions responsible for the survival of larvae and, therefore, for variations in intensity and in the time of setting? Because our voluminous data are still not completely analyzed we can offer at this time only a general discussion of some factors without a complete evaluation of their importance. We hope, nevertheless, that later on, upon completion of a thorough statistical analysis of the material already available, we shall definitely establish the presence or absence of correlations between some of the ecological factors and intensity of setting.

Temperature is the first factor that always comes to mind when considering oyster propagation. It cannot be denied that low temperature prolongs the larval period, thus exposing the larvae for several more days to their enemies and other unfavorable conditions. However, we do not think that fluctuations in temperature in Long Island Sound during any particular summer or, as recorded during different summer may kill the larvae. The old conception that a sudden decrease in temperature of

2 or 3^{o} would kill the larvae has been disproven by our field observations (Loosanoff and Engle, 1940). Recent observations at Milford Laboratory by my colleague, Harry C. Davis, showed that if larvae kept at a steady temperature of about $22.0^{o}C$. were placed directly in cold water of about $8.0^{o}C$.,and after being kept there for 30 minutes were again transferred back to $22.0^{o}C$., they would survive this treatment, even if it was repeated several times at two-day intervals. The work of Spärck (1927) also showed that the larvae of O. edulis withstood quick cooling from approximately 20.0 to $0.0^{o}C$. and were even able to survive at the latter temperature for at least 24 hours. Obviously, small fluctuations in temperature, as observed in the summer time in Long Island Sound, should not result in mass mortality of larvae.

Although temperature may affect the larvae by prolonging their swimming period or by affecting the quantity or quality of their food supply, no clear-cut relation was found between the departure of temperature from the mean during the periods between July 1 and September 30 and intensity of setting. It is interesting that the heaviest set of twelve years, which occurred in 1940, was during the year when the temperature departure was considerably below average. It is emphasized, however, that a further and more detailed analysis of our data may indicate that although no correlation between temperature and setting was noticed when long periods were considered, certain correlations may be found when the data are examined on a monthly, semi-monthl or weekly basis.

The changes in salinity in Long Island Sound are so small that they certainly cannot be regarded as responsible for the mortality of the oysters. Roughly, our salinity range is between 25.0 and 28.0 parts per thousand. Usually the changes in salinity of the water for the same period of the year seldom exceed 2.0 parts per thousand, and not in a single case did we find that the salinity for the corresponding week in twelve years exceeded 3.0 p.p.t. However, although these changes are not great enough to cause mass mortality of larvae they may, nevertheless, reflect on the production of the food on which larvae exist. This phase has not been thoroughly investigated as yet.

The percent of sunshine during the breeding period of oysters should also be considered as one of the factors which may have an important influence on the survival of larvae. This, of course, does not mean that intensity of light itself may kill or stimulate the growth of larvae. Its effect is largely confined to the growth of plankton forms which may serve as food for oyster larvae. Again, preliminary analysis of the data showed that in Long Island Sound the intensity of setting for the entire season was not correlated with the percent of sunshine during the period from July 1 to September 30. Nevertheless, it is possible that later on, upon a more detailed analysis, some correlation may become apparent.

Since, at present, none of the above discussed causes appears to be dominant in causing mass mortality of larvae, one,naturally, turns to look in another direction for an explanation why larvae disappear in our waters. We shall discuss two of the possible reasons, the first being extermination of larvae by their enemies and the second, death of larvae because of lack of food.

There is no doubt that a high percentage of larvae is eaten by their enemies, and that, in some cases, the presence of a large number of enemies may be the primary cause of failure of oysters to set. It is doubtful, however, that the failure of set in Long Island Sound is primarily due to that cause. Were we to assume that oyster larvae disappear because they are eaten, we would naturally expect to notice a similar disappearance of the larvae of closely related species of mollusks, such as clams,

[illegible] (1961). Dutton observed [illegible] checked that 12 hours [illegible] in cold month of about [illegible] brands had been [illegible] was repeated several times [illegible] the layer of [illegible] would have [illegible]

[illegible] temperature may affect [illegible] alter the quality or quality [illegible] between the numbers of [illegible] and 100 [illegible] of the two [illegible]

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[illegible] growth of [illegible]

[illegible]

[illegible]

mussels, teredos, etc., which live in the same environment with oysters and have the same enemies. Our observations show that this is not the case. During several summers, including that of 1948, while oyster larvae were relatively few in number, the larvae of all ages of the clam, Mya arenaria, and of some other lamellibranchs were numerous. Furthermore, while the oysters failed to set, or set in extremely small numbers, heavy setting of Mya and mussels continued throughout the summer. Thus, since regardless of the presence of common enemies, the larvae of many lamellibranchs survive in large numbers to the setting stage, we should expect a similar rate of survival among oyster larvae. This, however, was not borne out by our observations.

We all know that in the southern states the fouling of shells with various organisms presents a definite problem because these organisms deprive the larvae of setting space. Most of these organisms are also larvae eaters. Furthermore, in addition to the bottom forms there are large numbers of jellyfish and other pelagic larvae-eating organisms. Yet, regardless of such a large variety and the large numbers of larval enemies heavy oyster sets occur rather regularly.

In Long Island Sound, on the other hand, the bottom fouling forms are fewer in species and numbers than, for example, in Chesapeake Bay or in the Carolinas. Although a few of our shells, planted in early July, may be found silted by the end of the season, very few of them would be encrusted with barnacles, ascidians, etc., as is almost always the case in southern waters. Obviously, the Larvae enemies in our waters are not as numerous as in some other areas where good sets are, nevertheless, produced regularly. Thus, even if the larval period in our waters is longer than in the South, it still is improbable that the failure of our sets would be due almost exclusively to the activities of the larval enemies.

I can cite another example of the same type. In Connecticut waters the best and most consistent sets occur in the small, rather well-protected area of the Thimble Islands. The slopes of the shore of these Islands are extremely heavily populated with different organisms which are plankton feeders. Large sections of the bottom are also heavily populated with larvae-eating invertebrates. Yet, regardless of such a predominance of enemies the oyster larvae there survive and set in large numbers, while the Sound proper experiences one failure after another. Obviously, if larvae enemies were the chief causes of failure of setting, the Thimble Islands area should not be a good place for the propagation of oysters.

We may conclude after the above discussion that while the importance of larval enemies is understood, and while it is recognized that the damage they do to the population of oyster larvae is rather extensive, it still seems improbable that in our waters, where the larval enemies are not as numerous as in other oyster-producing areas, failure of sets should be ascribed mainly to the activities of these enemies.

The final cause which we wish to consider in this article is that of lack of proper food for the oyster larvae. At first the suggestion that under natural conditions oyster larvae may perish from starvation in large numbers sounds highly improbable. Several years ago I would not even have considered such a suggestion because I know that, as a rule, the waters of Long Island Sound are comparatively rich in plankton. Yet, during the last few years, especially since the work on cultivation and physiology of oyster larvae was begun at our laboratory, more and more evidence is accumulating that oyster larvae cannot utilize most of the forms of ultraplankton regardless of their small size. A more detailed discussion of this subject will be given to you by my colleague, Harry C. Davis, who did work on oyster larvae, while I shall limit myself to only a few remarks.

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[illegible]

[illegible]

It has been found that the addition of mixtures of laboratory cultures of ultraplankton forms measuring from 2 to 5 microns in size, thus small enough to be swallowed by the larvae, will not make oyster larvae grow. Apparently the mixture of plankton given to the larvae did not contain forms which could be assimilated by them Yet, the same food given at the same time to cultures of larvae of other lamellibranchs was readily utilized by them. Thus, while, regardless of the presence of numerous ultraplankton organisms, oyster larvae refused to grow, the larvae of other species of lamellibranchs thrived on the same forms. This, of course, indicated the inability of oyster larvae to assimilate the ultraplankton forms which were present in the food cultures.

I think this phenomenon is extremely well illustrated by the experiment which I devised and which I asked my colleague, Mr. Davis, to perform for me. Last winter oysters and clams, Venus mercenaria, were made to spawn on the same day but in separate containers. A day or so later, after the larvae of both species had reached the straight hinge stage, we placed the larvae of the clams and oysters in the same container and began to feed them with a mixed culture of laboratory-grown food culture containing a large number of ultraplankton. Three days later the clam larvae had grown in size to 105 μ while the oyster larvae were still 75 μ. Five days after fertilization some of the clam larvae were already measuring 125 μ, while the majority of the oyster larvae were practically at the same stage as at the beginning of the experiment. After eight days the clam larvae were over 140 μ while the oyster larvae were still between 75 and 80 μ the majority showing no growth whatsoever. At the end of the ninth day the clams were growing very vigorously showing almost no mortality and measuring about 160 μ while the oysters were dying in large numbers and those living were still measuring only between 75 and 80 μ. After 12 days the clam larvae were finishing their free-swimming period and were setting in large numbers while all the oyster larvae were dead or dying. None of the oyster larvae were larger than 80 μ.

Several variation of this experiment were run to be sure that the oyster larvae were not deprived of their food by the larger and more vigorous clam larvae. To achieve this some cultures were composed of a large number of oyster larvae and relatively few clam larvae. Regardless of the ratios between the clam and oyster larvae and the ratios in number of larvae per given volume of water the results were always the same, namely, that the clam larvae grew very rapidly on the food they were given while the oyster larvae showed no growth.

Similar experiments were repeated by Mr. William Miller and me but instead of using hard shell clam larvae, the larvae of the surf clam, Mactra solidissima, were used. The results were the same - while the clam larvae grew, the oyster larvae remained approximately the same size they had reached upon entering the straight hinge stage. These experiments clearly demonstrated that oyster larvae cannot grow and survive on forms of ultraplankton which can be utilized by the larvae of other related species.

It is interesting that our observations on the food of oyster larvae are indirectly supported by a pioneer in larval culture, W. F. Wells. Wells established a hatchery at Cold Spring Harbor for the cultivation of oyster larvae but was unable to obtain any sets until the hatchery was moved to another location where the characte of the water was different. Although at that time Wells did not realize the reason fo his initial failure it is probable that the water of Cold Spring Harbor contained no micro-organisms which could be utilized by the oyster larvae. The new location, however, was probably rich in such forms.

[illegible]

Our field observations support our contention that there may be a difference in the ability of various mollusk larvae to utilize the food found in the water. For example, to any investigator familiar with the conditions in Long Island Sound it always appears peculiar that while clam larvae of all stages are almost always found during the summer, oyster larvae seem to disappear within a few days after they hatch from the eggs. Is it not possible that this disappearance is due to the fact that during those periods our waters lack the food which can be assimilated by oyster larvae? Since it has been clearly demonstrated by our laboratory experiments that oyster larvae are unable to utilize many forms of ultraplankton, we are led to believe that the absence of proper food may be the cause of the failure of oyster larvae of Long Island Sound to live to the setting stage. This conclusion coincides with the opinion of Thorson (1946) who also thinks that lack of food is probably the chief reason responsible for the fluctuations of the larvae population in the sea.

Of course we still are very far from offering the final answer to this interesting and important problem. We know that in the first place it still is undetermined what forms in the plankton of Long Island Sound are utilized by oyster larvae. Secondly, the appearance or disappearance of such food forms would be very closely related to the environmental factors, such as probably temperature, solar radiation, presence of certain nutritive substances, such as phosphates, nitrates, etc. These relations remain to be determined, and all the data should be more fully analyzed and studied. Nevertheless, I think we are now approaching the solution of the problem why the intensity of oyster sets in northern waters varies so greatly from year to year.

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TOXIC EFFECTS OF OIL MIXED WITH CARBONIZED SAND ON AQUATIC ANIMALS

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Chamberlin Hotel, Old Point Comfort, Virginia, June 9, 1949

Oil pollution of inshore coastal waters is a problem of major importance for the conservation of our aquatic resources. Aside from being destructive to aquatic animals and plants, oil and other organic liquids floating on the water are a great nuisance to such recreational activities as boating and bathing and create a serious fire hazard, especially around piers and other structures built of creosoted wood.

After a damaging fire at the Norfolk Naval Shipyard, resulting from the accidental ignition of oil floating on the water, the Chemical Laboratory of the shipyard undertook a comprehensive study of the existing methods of removal of oil slicks and began a search for better ones. The experimenters of the Navy found that a carbonized sand can be prepared simply and cheaply by roasting creosote and sand in a specially designed kiln and that this has remarkably good organophilic and hydrophobic qualities. The sand, with its carbon coating, is sprayed on the surface of an oil slick. Coming in contact with oil, the carbon coating forms a stable bond with the oil. The mixture may then be readily removed. If on the surface of the water, the combined sand and oil may be sunk by a stream of water under pressure or by some other method of agitation. The bonding of the oil and carbon surface of the sand is permanent and an oil slick thus treated remains anchored on the bottom.

A popular account and graphic story of this new way of removal of oil slicks appeared in "Life" (1947, Vol. 23, No. 19). The caption to one of the photographs accompanying this article stated that the submerged sludge "is lethal to most marine life." Since there was no corroborative evidence of the toxicity of oil bound by carbonized sand, the United States Navy, through its Bureau of Ships, asked the cooperation of the Fish and Wildlife Service in a study of the problem. The present report summarizes the results of the experiments conducted in compliance with this request.

Oils discharged into coastal waters do not remain floating indefinitely. They are absorbed by particulate matter suspended in the water. Agitation of the water by currents and wave action helps the settling of the oil-saturated material on the bottom, but the oil slick is not securely fixed and may be carried to distant places. This characteristic behavior and its importance in aquatic life has been emphasized by Nelson (1925) and Gowanloch (1935).

Injury caused to ducks and other water birds by oil floating on the water is well known, since many instances have been recorded of the finding of oil-smeared birds unable to fly (Lincoln, 1936; Adam, 1936). Likewise sedentary animals living within the tidal zone and coming in direct contact with oil may be destroyed.

The toxicity of oil in sea water, due to water soluble substances extracted from oil, has been demonstrated many times experimentally using fishes and marine invertebrates. (Seydel, 1913; Nelson, 1925; Roberts, 1926; Gardiner, 1927; Ministry of Transport and Ministry of Agriculture and Fisheries, Joint Committee on Damages to Fisheri 1930; Gowanloch, 1934; Galtsoff et al.,1935; Galtsoff, 1936; Veselov, 1948, and other

Since there is convincing evidence of the leaching out of toxic substances from oils present in sea water, it is desirable to ascertain whether the combination of oil with carbonized sand would alter this action. The combination may either lessen the toxicity of the oil, or it may increase it by bringing the poisonous oil closer to the bottom dwelling forms, permanently anchoring it there, and allowing a slow and continued extraction.

For our study we selected for experimental animals such forms that would normally live attached to submerged objects, or on the bottom in estuaries and harbors wher this type of pollution is most apt to occur. We chose in particular animals of known economic importance, but also included others which aptly lend themselves to the experimental procedures desired. We used the following organisms; the hydrozoan Tubular crocea, which grows attached to polings and docks; the barnacle Balanus balanoides, a very common form growing abundantly on rocks and structures near low tide mark; the embryos of the toadfish Opsanus tau, one of the common bottom-dwelling fishes in harbors and bays which attaches its large eggs to wood, rocks, and other submerged object the hard shell clam Venus mercenaria, which inhabits the mud flats; and the oyster Ostrea virginica, found on rocks and on the bottom in all coastal waters.

The oils tested were supplied by the Navy. These included crude oil, Navy Grade Special fuel oil, lubricating oil (SA 20), and Diesel oil.

Because of the necessity of making this paper short, only a brief summary of the many experiments performed can be presented. A more complete description of the experiments and the results obtained in each is soon to be published.

Experiments with Tubularia crocea

Weakened or dying polype of Tubularia lose their dark pink color and become slightly opaque. Their tentacles fail to respond to touch and, finally, the entire hydranth, with its whorl of filliform tentacles, separates and drops off, leaving dens tufts of tangled stems. This characteristic change makes it convenient to employ colonies of Tubularia as test animals. The death point of an individual hydranth may be taken as the time when it drops off the stem and the progress of mortality in the grou can be easily expressed in the number of lost hydranths.

The tests made with Tubularia consisted in determining the survival of this organism in standing or in running sea water containing known quantities of mixtures of various oils and carbonized sand, and in its survival in water to which an extract of crude oil was added. Relatively dilute concentration of oil or oil mixed with carbonized sand were toxic to Tubularia in standing solutions, a strength of 1:1000 killed about 33% within 24 hours. Apparently there is sufficient toxic material leached out in a short time to be deleterious to this organism. When this is made more dilute by a flow of sea water, the injuriousness is less pronounced. With a flow of 65 to 75 liters per hour a toxic effect becomes apparent after 48 hours if 5 ml. or more of oil mixed with sand are placed in the immediate vicinity of Tubularia in a 2-liter jar.

The results comparing different oils show that lubricating oil was least toxic, while crude oil appeared to be the most toxic. The toxicity of the crude oil apparently resulted from something leached from the oil by water, for extracts were found to be toxic to Tubularia.

Experiments with Barnacles, *Balanus balanoides* (Ag.)

Adult barnacles can be conveniently used in toxicological tests. Being sessile, the barnacles can be easily arranged in a desired position in the experimental set-up. The effect of a toxic substance can be studied by observing and timing the sweeping of their cirri. In running sea water or in containers in which the water is renewed dail they remain active and apparently in good condition in the laboratory for many days and weeks.

The test performed clearly demonstrated the toxic effect of crude oil and sand mixtures placed in the immediate vicinity of barnacles. A slowing of the cirri was observed within 6 hours in the weakest concentration tried, 1:50. Poisoning was progressive and complete death of 80 to 90% of the barnacles took place within 70 hours.

Experiments with toadfish embryos, *Opsanus tau* (Linn.)

Toadfish embryos present excellent material for bioassay; they are large, fairly transparent, and are attached by egg membranes to pieces of wood, stone, shells, and similar objects. Normally they are quite active in the laboratory jars and the beating of their hearts and the circulation of blood can be easily observed with adequate illumination and suitable optical equipment.

Crude oil mixed with carbonized sand was found to be quite toxic. Even the lowest concentration of 1:200 was sufficiently toxic to kill all the embryos in 11 days. The mortality of embryos in water with greater quantities of oil was more rapid. If the log of the survival time is plotted against the log of concentration, the toxicity curve approximates a straight line. The linear relationship obtained by such plotting can be approximately represented by a general equation of the type $y = a x^c$ and the constants a and c may be computed from the empirical data.

The relative toxicity of the different oils mixed with carbonized sand was ascertained. Crude oil added in the ratio of 1:40 killed three out of five test embryos within $47\frac{1}{2}$ hours. Toxicity of Diesel oil was noticeable within 52 hours in the concentration of 1:20, while lubricating oil was ineffective even in the concentration of 1:10 (50 hours).

Experiments with hard shell clams, *Venus mercenaria* (Linn.)

The hard shell clam, chosen for experiments because of its economic value, is frequently found in polluted bottom of harbors and bays. Because of their ability to close themselves within their shell, clams, like oysters, are capable of slowing down their activities to a low minimum for rather protracted periods of time. In this way they may reduce the immediate effect of unfavorable conditions.

In the one experiment performed, the sea water supply to the clams flowed at the rate of 21 liters per hour through containers containing 20 ml. of an oil or an oil and sand mixture. None of the clams died during the $12\frac{1}{2}$ days of the test in the sea water containing crude oil, fuel oil, Diesel oil, or lubricating oil or mixtures of these oils with carbonized sand. There was no evidence of their weakening.

Experiments with Oysters, *Ostrea virginica* (Gm.)

Because of its great economic importance, the oyster has been studied more than most marine invertebrates. Consequently, its physiology, habits, and life history are better known than other lamellibranchs. Living attached to rocks or lying on the

bottom it is frequently affected by oil wastes discharged into waters. Having no means of moving from unfavorable environments, the oyster protects itself by tightly closing its valves. If the inimical condition persists, the oyster is eventually damaged or killed.

Tests of the toxicity to oysters were made of standing water to which were added crude oil in a dilution of 1:500 and Diesel oil in strengths of 1:200, and similar strengths in which the oils were sunk to the bottom mixed with carbonized sand. In the test with Diesel oil the first death occured on the third day with an oil layer on the surface, and on the fourth day in the aquarium with the oil and sand mixture. By the end of the test on the 13th day, the mortality was 67 percent in the test with oil on the surface against 25 percent with the oil treated with carbonized sand. There was no mortality among the control oysters. Experiments with crude oil added in the ratio of 1:500 gave similar results. In these the first death was observed in the ninth day and the mortality was less pronounced, due probably to the smaller quantity of oil used.

In experiments with oysters kept in large tanks of running sea water and exposed to a mixture of crude oil and carbonized sand, no toxicity was observed in the 35 days of the test. It was found that 500 ml. oil introduced into a water system running at the rate of 180 liters per hour and anchored by carbonized sand were insufficient to cause mortality or to inhibit the growth of the shells of adult oysters.

The maintenance of a steady flow of water through the gills of an oyster is essential for its feeding and respiration. The measurement of the rate of filtration of water is a very sensitive means of studying the effect of changes in the environment of the oyster, for the organism rapidly reacts to the presence of toxic substances which may be introduced into natural waters. Methods are available at present for measuring the efficiency of the ciliated mechanism concerned with pumping alone or for obtaining the over-all picture of the function of the entire pumping system involving also the mantle and shell. Experiments were performed with each method, the former known as the carmine-cone technique and the latter the apron method (see Galtsoff, et al.,1947).

It is impossible in this short paper to describe in detail the numerous experiments performed and the results observed using the various oils mixed with carbonized sand, and extracts of these oils in experiments in the physiology of oysters. We conclude from the various tests we performed that there was a release of physiologically active substances which suppress the activity of the ciliated epithelium of the gills of the oyster and that the anchoring of oil by carbonized sand does not prevent this release.

Summary

We found that crude oil, Diesel oil, and Navy Grade fuel oil added to sea water are toxic to the various animals normally inhabiting estuarine environments, the more sensitive forms being killed rather promptly when compared to the forms known to be more hardy. The toxicity of these oils is apparent whether they are present as oil slicks on the surface of the water or are held on the bottom bound to carbonized sand. This toxicity results from material leached out of the oil by water. The oyster responds to relatively weak concentrations of the toxic materials leached from oil by a marked reduction in the amount of water filtered for respiration and feeding and a decrease in the number of hours open.

There is definite advantage in the use of carbonized sand in treating oil slicks for it localizes the oil pollution, prevents the spread of oil over the surface of water, and submerges and permanently anchors the oil near the source of pollution. In view of the fact that bottoms of harbors and bays near industrial ports are grossly polluted and non-productive, the sinking of oil in these localities will not increase the damages to the fisheries.

Dusting with carbonized sand is a highly efficient method of removal of oil from the surface of the water. It is useful around docks and piers to combat fire hazards and also has distinct advantage in preventing the movement of oil slicks to productive areas where great injury to sea food resources may occur. We hope that the method will be adapted in some way to have more general use in combatting oil pollution in coastal waters.

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REPORT OF THE RESOLUTIONS COMMITTEE

At the Closing Session of the Annual Convention at Hotel Chamberlin, Old Point Comfort, Virginia, June 9, 1949

The Resolutions Committee, consisting of John L. Plock, William R. Woodfield, and James E. Munson, Chairman, was asked to consider several topics. All were of importance, but in some cases we decided that a resolution was either out of order or unnecessary. In this latter category was the suggestion made by V. L. Hodges in his excellent address on transportation matters in which he asked that the Oyster Institute's Traffic Committee be empowered to cooperate with a similar committees of the National Fisheries Institute and any other such organization with the idea of co-ordinating our traffic work with that of other sections of the fishing industry. Your Resolutions Committee believes that our Traffic Committee was given these powers to be used at its discretion when it was originally formed, and hence no separate resolution is necessary at this time, though the merits of cooperation and coordination are plainly evident.

Five resolutions, unanimously adopted, are as follows:

WHEREAS, Almighty God has seen fit to take from this world one of the most charming and gracious of women, Mrs. Lewis Radcliffe, whose sweet character and unfailing graciousness were known to all with whom she ever came in contact, and

WHEREAS, We who were privileged to know her well are also well aware of the courage and comfort and inspiration she gave not only to her immediate family but also to her vast circle of friends in all walks of life,

BE IT RESOLVED, That this convention mark its sincere sense of loss by tendering its deep sympathy to our director, Lewis Radcliffe, whose personal loss so far surpasses our own, and to whom we say in all humbleness that May Radcliffe's memory will live in our hearts forever.

***

WHEREAS, Since our last convention Death has removed from our ranks two of the oyster industry's most stalwart champions, Joseph N. Fowler of New Jersey and Charles E. Wheeler of Connecticut, and

WHEREAS, These men were outstanding in the vigor and effectiveness of their work on behalf of oyster growers of New Jersey, Connecticut, and the country as a whole, notably in the tremendously important fields of legislation and water sanitation.

BE IT RESOLVED, That the Oyster Growers and Dealers Association pay tribute to these valiant warriors and indicate our public recognition of our distinct loss by the unanimous adoption of this resolution of respect and gratitude, with instruction to our Secretary to inscribe this on the minutes of the convention and to send copies to their surviving families.

***

WHEREAS, The greatest need of industry today is a reduction in government expenses, and one of the most effective ways of accomplishing this would be by effectuating the recommendations of the Hoover Commission, and

WHEREAS, There was lack of accord as to whether the fisheries division should be set up as a separate entity and as to whether it should be retained within the Department of Interior or transferred to some other department, such as Commerce, and

WHEREAS, The fishing industry itself has as yet arrived at no definite policy with respect to these matters,

THEREFORE BE IT RESOLVED, That those assembled in this convention on this ninth day of June 1949 urge that immediate steps be taken by the various trade associations and the members of the industry to formulate and agree upon a specific policy and take the necessary steps to see that it is put into effect, and

BE IT FURTHER RESOLVED, That we commend a study of the proposals presented by Mr. David Meyers, Publisher of Fishing Gazette, at this convention.

***

WHEREAS, As so ably portrayed by Gordon Sweet there exists the need for a study of ways of increasing the consumer demand for oysters with particular reference to the field of public relations,

THEREFORE BE IT RESOLVED, That this group in convention assembled requests its President to appoint a committee to make an immediate study of this subject and report its conclusions to him at the earliest practicable date, and

BE IT FURTHER RESOLVED, That upon the completion of this report the President be requested to call a meeting of the Directors to determine the policy that should be adopted to effectuate these proposals, and

BE IT FURTHER RESOLVED, That we commend Mal Thompson of Southern Fisherman for his presentation of "Point of Sale Merchandising" as one of the approaches to the solution of this problem.

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WHEREAS, Over the past several years there has been a strong and increasing trend in the food industry towards the development of packaged frozen foods of all types, and

WHEREAS, Many members of the oyster industry have been working individually on the problem of suitable containers and freezing methods with the aim of turning out the finest possible pack,

BE IT RESOLVED, By the Oyster Growers and Dealers Association in convention assembled that to aid in the further development of this branch of the oyster industry the United States Fish and Wildlife Service be urged to have its fishery technologists (1) make studies to determine the adaptability of the newer packaging materials to frozen oysters and (2) conduct research on the use of vitamin C (ascorbic acid) to prevent discoloration in the frozen product.

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Proc. NSA, 1949, 1950